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VOL. CXXXIII.—No. 3458] LONDON: FRIDAY EVENING, APRIL 7, 1922 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
WIRE, IRON, GALVANISED.
PIPES, STEEL, LAP-WELDED OR RIVETED.
Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Tuesday, the 25th April, 1922.
T. RYAN,
Director-General.
7893

The Manchester Steam Users' Association.
The ANNUAL GENERAL MEETING of the Members was held in the Board Room of the Association, at their Offices, 9, Mount-street, Manchester, on Friday, March 31st, Harold Lee, Esq., J.P. (Manchester), President, in the chair, when the following Resolutions were adopted :—
Moved by the Chairman, seconded by J. T. Browne, Esq., Pendlebury (Vice-Presidents), and resolved :—
"That the Report of the Committee of Management to the Subscribers be adopted."
Moved by W. Geddes, Esq. (Messrs. W. T. Glover and Co., Ltd., Manchester), seconded by A. E. Davy, Esq. (Peel-Connor Telephone Co., Ltd., Salford and Coventry), and resolved :—
"That the thanks of the Association are due and are hereby presented to the Committee of Management for their past services, and that the following gentlemen be elected the Committee for the ensuing year, with power to add to their number :—
COMMITTEE OF MANAGEMENT.
Harold Lee, Esq., J.P., Manchester.
A. Norman Dugdale, Esq., J.P., Blackburn.
Jas. Stanley Addison, Esq., Manchester.
J. T. Browne, Esq., Pendlebury.
Alfred H. J. Cochrane, Esq., Openshaw.
Charles W. Crossley, Esq., Halifax.
Charles Roberts, Esq., Manchester.
Moved by T. Hutchinson, Esq. (Fine Cotton Spinners and Doublers' Association, Ltd., Manchester), seconded by H. J. Hampton, Esq. (Chloride Electrical Storage Co., Ltd., Clifton Junction), and resolved :—
"That Messrs. F. W. Popplewell and Son, Chartered Accountants, Manchester, be appointed Auditors of the Association's accounts for the year 1922."
JAMES PARR,
Secretary.
9, Mount-street,
Albert-square, Manchester.
April 1st, 1922. 7912

The Proprietors of Letters Patent No. 121,421, relating to
ROCK-DRILLING MACHINES,
DESIRE to DISPOSE of their PATENT or to GRANT LICENCES to interested parties on reasonable terms with a view to the adequate working of the patent in this country.—Inquiries to be addressed to
CRUIKSHANK and FAIRWEATHER,
85-86, Chancery-lane, London, W.C. 2. 7902

University College of South WALES AND MONMOUTHSHIRE.
COLEG PRIFATHROFAOL DEHEUDIR CYMRU
A MYNWY.
THE "ARCHIBALD DAWNAY" SCHOLARSHIP.
This SCHOLARSHIP of £50 a year, tenable for three years by a student who intends to enter some branch of the engineering profession, will be OFFERED for COMPETITION at the College Entrance Scholarship Examination which begins on April 22nd, 1922. Further particulars and a form of application can be obtained from the undersigned, to whom the form of application must be returned on or before April 15, 1922.
D. J. A. BROWN,
Registrar.
Cardiff, March 29, 1922. 7884

Bengal-Nagpur Railway Company, LIMITED.
The Directors are prepared to receive TENDERS for the following :—
TWO 40-TON STEAM WRECKING CRANES.
Specifications and forms of Tender can be obtained at the Company's Offices, 122, Gresham House, Old Broad-street, London, E.C. 2, on or after 4th April, 1922.
A fee of £1 1s. will be charged for the specification, which will not be returned.
Tenders must be submitted not later than Noon on Wednesday, 19th April, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
T. E. WYNNE,
7897 Managing Director.

Borough of Royal Leamington Spa.
REINFORCED CONCRETE BRIDGE OVER THE RIVER LEAM.
TO REINFORCED CONCRETE WORK CONTRACTORS.
The above-named Council invite TENDERS for the CONSTRUCTION of the above BRIDGE, together with RETAINING WALL in connection therewith. The bridge will be in three spans, one of 44ft. and two of 42ft., with a width between parapets of 40ft.
Specifications, bills of quantities, and form of Tender may be obtained from, and plans inspected at the office of, the undersigned on deposit of £5, such sum to be returned on receipt of a bona fide Tender and of all documents supplied.
Copies of plans may be inspected at the office of the Quantity Surveyors, Messrs. Martin and Griffith, 17, Bedford-row, London, or the Trussed Concrete Steel Co., Ltd., 23, Cranley-gardens, South Kensington, London, on whose system the bridge is to be constructed.
The Council do not bind themselves to accept the lowest or any Tender.
Tenders, endorsed "Bridge," to be delivered at my office on or before Noon on Thursday, the 27th April, 1922.
J. J. KENNAN,
Borough Engineer.
Town Hall, Leamington Spa,
1st April, 1922. 7804

The National Foremen's Association of the ENGINEERING AND ALLIED TRADES.
(Registered under the Trade Union Act.)
An Association specifically formed to look after the interests of Foremen in their Supervisory Capacity.
All communications to Head Offices.
E. W. REID, 95, Belgrave-road,
General Secretary. Victoria, S.W. 1.
Ex.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Chinese Engineering Notes.
Utility Arc Welding.
The Institution of Naval Architects.
Six-Ton Under-Type Steam Wagon. (With a Two-Page Drawing.)
March Engineering Notes.
British and American Locomotives.
The Milling of Screw Threads.
Electricity on the Farm.

PUBLIC NOTICES

Borough of Swindon.
SEWAGE PURIFICATION WORKS, RODBOURNE.
CONTRACT No. 1.
The Corporation of Swindon is prepared to receive TENDERS for the CONSTRUCTION of DETRITUS TANKS, CARRIERS, BUILDINGS, SETTLING TANKS, FILTER BEDS, HUMUS TANKS, MAINS, and other Works at their Sewage Works at Rodbourne, in accordance with drawings, general conditions and specification prepared by the Engineer, Mr. G. Middley Taylor, of Messrs. John Taylor and Sons, 38, Victoria-street, Westminster, S.W. 1.
The specification, bill of quantities and form of Tender may be obtained from, and the drawings seen at, the office of the Engineer upon payment of £3 (cheque only), which will be returned upon receipt of a bona fide Tender.
Sealed Tenders, endorsed "Rodbourne Sewage Disposal Works," addressed to the Town Clerk, are to be delivered at his office, Town Hall, Swindon, at or before 10 a.m. on Friday, the 5th day of May, 1922.
The Corporation does not bind itself to accept the lowest or any Tender.
(Sgd.) RODT. HILTON,
Town Clerk.
Town Clerk's Office,
Town Hall, Swindon,
6th April, 1922. 7913

County Borough of Brighton.
The Corporation invite TENDERS for the SUPPLY, DELIVERY, and ERECTION at their Power Station, Southwick, near Brighton, of :—
(1) ONE 6000 K.W. Normal Rating TURBO-ALTERNATOR and EXCITER, with CONDENSER, and complete with all necessary Accessories.
(2) ONE House Service GEARED TURBO-DRIVEN D.C. GENERATING PLANT, comprising Two 200 K.W., 230/280-Volt Shunt-wound Generators in tandem, complete with Condenser and all necessary Accessories.
Specifications and any further information may be obtained on application to the Engineer and Manager, Mr. John Christie, Electricity Department, North-road, Brighton, on payment to him of the sum of £2 2s. and £1 1s. for (1) and (2) respectively. These amounts will be returnable only if bona fide Tenders are submitted and not withdrawn.
Sealed Tenders, marked "Tender for Turbo-alternator" and "Tender for House Service Turbine," respectively, must be delivered to the undersigned not later than Twelve Noon on Monday, the 8th May, 1922, at the Town Hall, Brighton.
The Corporation do not bind themselves to accept the lowest or any Tender.
HUGO TALBOT,
Town Clerk.
Town Hall, Brighton,
1st April, 1922. 7885

The Ilford Urban District Council invite TENDERS from firms experienced in the construction of reinforced concrete work of the Considere type, for the CONSTRUCTION of RED BRIDGE, span 40ft., width 60ft.
Specifications, details and quantities of the above bridge may be obtained from HERBERT SHAW, Esq., Engineer and Surveyor, Town Hall, Ilford, on payment of a deposit of £2 2s., which will be refunded on receipt of a bona fide Tender.
Plans and details can be seen at the above-mentioned office. Latest date for receiving Tenders, Tuesday, April 25th, 1922.
Town Hall, Ilford,
April 3rd, 1922. 7880

PUBLICATIONS.

"PROCEEDINGS," INST. CIVIL ENGINEERS, Vols. 188 to 196 inclusive, uncut. What offers ?—Address, P5225, The Engineer Office. P5225

PUBLIC NOTICES

Metropolitan Water Board.
SUPPLY OF CAST IRON PIPES AND SPECIAL IRREGULAR CASTINGS.
The Metropolitan Water Board invite TENDERS for the SUPPLY of approximately 3325 TONS of CAST IRON SOCKET PIPES (36in., 42in., and 48in. diameter) and 250 TONS of SPECIAL IRREGULAR CASTINGS required in connection with the Walton to Honor Oak Main, Section No. 3. All pipes and castings to be to the British Standard Specification (Class B), except where specified to the M.W.B. Standard.
Forms of Tender and conditions of contract, &c., may be obtained at the offices of the Board (Room 150), New River Head, 173, Rosebery-avenue, E.C. 1, on or after Thursday, the 6th April, 1922, by personal application or upon forwarding a stamped addressed brief envelope.
Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Cast Iron Pipes, &c.," must be delivered at the offices of the Board not later than 11 a.m. on Thursday, 20th April, 1922.
The Board do not bind themselves to accept the lowest or any Tender.
W. MOON,
Clerk of the Board.
New River Head,
Rosebery-avenue, E.C. 1,
3rd April, 1922. 7907

SITUATIONS OPEN

April 4th, 1922.
BOMBAY PIPE LINE.—BRAITHWAITE and CO., Engineers, Ltd., REQUIRE the SERVICES of a good, capable, energetic GENERAL MANAGER for the above contract. The candidate must be a good organiser and have had experience in the Manufacture and Erection of Riveted Pipes and all classes of Structural Steel Work. He must be capable of controlling all classes of labour.
The engagement will be for three years, at a salary of £1500. Age between 35 and 40. Services to commence at the beginning of August, 1922. First-class free passage out and home on the satisfactory completion of engagement. The selected candidates will be required to pass a strict medical examination.
The letter of application, giving particulars of applicants' general and technical training, and showing in chronological order (with dates) where and how he has been employed, with particulars of the class of work, together with copies of three recent testimonials, should be addressed to the Secretary, BRAITHWAITE and CO., Engineers, Ltd., 117, Victoria-street, London, S.W. 1, and should be received not later than April 28th. 7921 A

April 4th, 1922.
BOMBAY PIPE LINE.—BRAITHWAITE and CO., Engineers, Ltd., REQUIRE for their office in Bombay the SERVICES of a good, capable, energetic CHIEF DRAUGHTSMAN. The candidate must have had experience in the Design, Manufacture, and Erection of Bridges and all classes of Structural Steel Work, also Riveted Pipes and Tanks, and be capable of controlling the drawing-office and dealing with correspondence.
The engagement will be for three years, at a salary of £500 per annum. Age between 30 and 35. Services to commence at the beginning of June, 1922. Second-class free passage out and home on the satisfactory completion of engagement. The selected candidates will be required to pass a strict medical examination.
The letter of application, giving particulars of applicants' general and technical training, and showing in chronological order (with dates) where and how he has been employed, with particulars of the class of work, together with copies of three recent testimonials, should be addressed to the Secretary, BRAITHWAITE and CO., Engineers, Ltd., 117, Victoria-street, London, S.W. 1, and should be received not later than April 28th. 7922 A

SITUATIONS OPEN (continued)

CHIEF ESTIMATOR REQUIRED by Firm of Engineers in the North, specialising in constructional steel work. To an experienced man fully conversant with present-day prices and qualified to take charge of the commercial staff, the position offers every possibility of advancement and a good salary. Replies, which will be treated in strictest confidence, should state age, salary anticipated, nature of experience, where gained, and how at present employed.—Address, 7910, The Engineer Office. 7910 A

ENGINEERS REQUIRED for the East (Several Juniors), with good general mechanical shops and drawing-office training. Age 23/28, single.
Three years' agreement. Salary £400 upwards and free accommodation.—Apply, stating age, full particulars, with dates of training and experience, to Box E, c/o The Regent Advertising Service, Ltd., 4, London Wall Buildings, E.C. 2. P5211 A

ENGINEER.—WANTED, Trained MECHANIC with good Electrical and Drawing-office Experience, for Near East. Age 25 to 30 years. Unmarried. Quarters and full board provided free.—Address, with references, stating experience and salary required, 7927, The Engineer Office. 7927 A

ENGINEER, with Extensive Knowledge of Storage and Handling of Grain. Must have had experience in planning and carrying out large contracts. Knowledge of foreign requirements essential. Experienced in negotiating important business abroad. Liberal salary and good prospects.—Box 590, Advertising Offices, 54, Queen Victoria-street, London, E.C. 4. 7916 A

WANTED, DRAUGHTSMAN, with First-class Up-to-date experience in Colliery Screening and Coal-handling Plants.—Apply, giving full particulars of experience, salary required, and age, to ERNEST NEWELL and CO., Ltd., Engineers, Misterton, via Doncaster. 7930 A

WIRELESS LOCOMOTIVES.—Thoroughly Experienced DRAUGHTSMAN WANTED.—Address, giving full particulars of experience, age, when free, wages required, 7883, The Engineer Office. 7883 A

STRUCTURAL DRAUGHTSMAN.—WANTED for London, S.W. District, a DRAUGHTSMAN, capable of taking full charge of drawing-office. Must be able to design, estimate, and detail all classes of Steel-framed Buildings, Workshops, Sheds, Staircases, &c. Only properly qualified men need apply, giving age, experience, salary expected, together with copies of references.—Address, P5227, The Engineer Office. P5227 A

FOREMAN, to Take Charge Power-house on Gold Mine, West Africa. Plant consists of triple-expansion engines, turbine, air compressors and 3-phase alternators. Salary £40 per month.—Address, giving full particulars experience, with copies testimonials and stating age, 7924, The Engineer Office. 7924 A

FOUNDRY FOREMAN REQUIRED. Must be Live man and keen on results. Small foundry, 24 miles from London. Ferrous and non-ferrous castings. State age, experience, and salary required.—Address, 7919, The Engineer Office. 7919 A

SITUATIONS WANTED

ADVISORY POST WANTED.

ADVERTISER, M.I. Mech. E., with Exceptional commercial and manufacturing experience at home and abroad, DESIRES a POST. Has successfully filled the position of director, general manager and works manager respectively in three of the largest firms in Great Britain. Can originate and carry through complete organisation of all departments. Moderate terms and would take a small interest to qualify as director in sound undertaking.
Address, P5174, The Engineer Office. P5174 B

B.Sc. (Eng., Lond.) DESIRES Thorough Practical EXPERIENCE in Electrical Works, preferably in electric railway engineering. Age 23, keen, excellent education, good references.—Address, P5235, The Engineer Office. P5235 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 3. 7906 B

ENGINEER (35), A.M.I.M.E., M.I.A.E., &c., Many years' experience works and business management, and with complete commercial experience, including sales organisation, experienced designer and with extensive knowledge of works accountancy, shortly relinquishing managing directorship, SEEKS responsible Managerial APPOINTMENT. Would entertain home, continental, or foreign representation.—Address, P4922, The Engineer Office. P4922 B

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SITUATIONS WANTED (continued)

ENGINEER (38), Mechanical, Locomotive, Rolling stock, thoroughly experienced works manager and organisation, two years' Indian experience, DESIRES Works Manager or District Representative APPOINTMENT.—Address, P5183, The Engineer Office. P5183 B

ENGINEER, Thoroughly Acquainted with the manufacture of high-grade gelatine from bone and skin, and all latest machinery connected therewith, SEEKS POSITION as CHIEF ENGINEER, home or abroad.—Address, P5236, The Engineer Office. P5236 B

ENGINEER (33), Chief's Certificate, B.O.T., DESIRES responsible POSITION; Lancashire, water-tube boilers, ice cold storage, ammonia compressors, ammonia absorption machines, internal combustion engines, general factory maintenance and marine installation oil fuel.—Address, P5232, The Engineer Office. P5232 B

ENGINEER (35 Years), 18½ Years' Sound Experience, marine, general, plant maintenance, experimental work, tools, jigs and fixtures; past 8 years in charge with important firm; strict disciplinarian, but can handle men with tact.—Address, P5239, The Engineer Office. P5239 B

WORKS ORGANISATION AND CONTROL. LOW PRODUCTION COST. SATISFIED PERSONNEL. ENGINEER, General Manager, with Exceptional administrative experience and proved ability in the efficient and economical organisation of all productive, technical and commercial departments in the largest works, British and American, DESIRES CHANGE (engineering production, automobile manufacture). A substantial salary will be asked and only a big proposition entertained.—Address, P5240, The Engineer Office. P5240 B

FOUNDRY MANAGER DESIRES POSITION as Manager, Foreman, or Adviser and Inspector. Thorough practical man with technical training; 16 years' experience as manager and foreman with large firms, green, dry sand, and loam up to 35 tons from loose pattern plate and machine, engine, tool, jobbing, steam turbine and electrical castings. Excellent metals and cupola practice, good control modern methods, good references. Age 42 years. Member F.M.B.A. Apply, confidence, W. PYATT, 5, Woodplumpton-road, Ashton, Preston. P5239 B

MECHANICAL ENGINEER (29), Articled, Sound technical training, 4 years' experience of works organisation and management, 6 years designer and chief draughtsman, shortly disengaged, REQUIRES responsible POSITION in progressive firm. Willing to invest moderate capital.—Address, P5102, The Engineer Office. P5102 B

DRAUGHTSMAN (49) DESIRES POSITION; 11 years' shop experience, many years as high-class jigs, tools and fixtures, installation and maintenance of cable plant; excellent references.—Address, P5226, The Engineer Office. P5226 B

EXPERIENCED BOILERMAKER (23) SEEKS responsible POSITION, any capacity; sound practical and technical knowledge, boilers, all types; examination and testing a speciality.—Address, P5233, The Engineer Office. P5233 B

APPRENTICE, Motor or Instrument Making Preferred. Youth, aged 17 years, 4 years secondary, 2 years technical (engineering) schools; good draughtsman.—GRANT, 9, Rookwood-road, N. 16. P5234 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.

46, Watling Street, London, E.C. 4.

Established seventy years.

ACTIVE DIRECTOR REQUIRED, with Knowledge of Engineering, in London company; full-time occupation; investment £5000. Salary, director's fees, and share of profits. Open to investigation by solicitors and accountants.—Write, Box K55, Hasco, Ltd., 81, Ann's Chambers, Ludgate-hill, E.C. 4. 7902 C

IRONFOUNDRY WANTED by Practical Moulder and Patternmaker, age 40, or would invest up to £2000 in engineering business and manage foundry department.—Reply, LEACH and CO., Solicitors, Cross-street, Manchester. P5219 C

PARTNERSHIPS and ACTIVE DIRECTORSHIPS WANTED in Mechanical, Constructional, Electrical Engineers, &c., for Clients with technical experience and capital from £1000 to £20,000.—GILBERT and PRATT, 19, Walbrook, London, E.C. 4. Ex C

PARTNERSHIPS, DIRECTORSHIPS, and EMPLOYMENT with Investment WANTED, for not less than £1000 and up to £20,000 in realty well-established businesses, in town and country. Our list (up to date) of investors sent, showing their ages, education, degrees, diplomas, certificates, &c., their past experience, and capital available. You can choose your candidate for immediate introduction.—THE OFFICERS' PARTNERSHIP GUARDIAN, 116, Victoria-street, S.W. 1. Call. 7877 C

AGENCIES

AGENCY.—ADVERTISER, with City Office, is OPEN to TAKE UP any good paying LINE, London district, or Represent Provincial Manufacturer. Correspondence invited. Ex. refs.—MARSHALL, 146a, Queen Victoria-street, London. 7882 D

AGENT, with Wide Connection in Sheffield, is WILLING to TAKE on an additional AGENCY for firm of engineers or similar of good standing.—Address, P5230, The Engineer Office. P5230 D

AGENTS REQUIRED for Sale of Lubricating Oils, &c. Liberal commission.—Write, stating territory and turnover, Box 1821, Sell's Advertising Offices, Fleet-street, E.C. 4. 7887 D

AGENTS WANTED by Belgian Engineering Firm, for Sale in England and Colonies and in Ireland of first-class Pumps and Compressors. Preference to French-speaking engineers. Apply, with references, to ATELIERS DE CONSTRUCTION D'ENSIVAL, SOCIETE ANONYME, Wegnes par Pepinster (Belgium). 7914 D

ESTABLISHED FIRM of ENGINEERS, with Offices in the City and good connection with steam users, are DESIROUS of REPRESENTING MANUFACTURERS of Prime Movers, Steam and Fuel Specialities. Will also Undertake to Manufacture and Market Improvements in Power Production or similar articles. Good connection with exporters in the London area.—Address, P5212, The Engineer Office. P5212 D

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ARTICLED PUPIL.—A CIVIL ENGINEER has VACANCY for well-educated young gentleman as PUPIL; good practical and theoretical training; interesting works in hand; premium required.—Address, 7895, The Engineer Office. 7895 E

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INST. C.E. Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Course can be commenced at any time.—39, Victoria-street, Westminster, S.W. Telephone No., Victoria 4780. Ex.

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Rlys.), Hollybank, Woking. P5210 B

MISCELLANEOUS

WANTED, ENGINEERS' PATTERNMAKING. L. HOWARTH, 12, Skipton-street, Harrogate. Estimates free. P5104 I

A SOUND INVESTMENT WITH OCCUPATION.—FRUIT GROWING under glass in England. Actual results available for inquirers. Capital from £3000.—HORTUS, Limited, Elden-street House, London, E.C. 2. P5196 I

HIGH-GRADE CASTINGS (Medium and Small) in brass and gun-metal, green, dried and fine. Low prices, quick delivery.—Send full particulars for quotation to P5229, The Engineer Office. P5229 I

ISLAY HOLMES, 1st B.O.T., M.I. Mar. E.—To those Buying Second-hand ENGINES, BOILERS, &c. Have them inspected and reported on before purchasing. Repairs also executed.—38a, Matthias-road, Newington Green, London, N. 16. P5213 I

QUOTATIONS WANTED for REMOVAL and RE-ERECTION of STEEL-FRAMED BUILDING, covered corrugated iron, steel principals, wood block paving. Now standing at Edmonton, for removal to Bromley-by-Bow, E.—Write, Box 1830, Dale's Advertising Offices, 44, Cannon-street, E.C. 4. P5214 I

PATENTS, INVENTIONS, TRADE MARKS DESIGNS. Advice and handbook free.—KING'S PATENT AGENCY, Limited (B. T. King, Director), 146a, Queen Victoria-street London. 85 years' refs. Tel., Central 682. 7830 F

PATENTS

THE PROPRIETOR of BRITISH PATENTS Nos. 9806/13 and 9807/13, both dated April 26, 1913, relating to "Roofing," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCES or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical workings in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 7900 H

THE PROPRIETOR of BRITISH PATENT No. 19,704/13, dated April 16, 1913, relating to "Improvements in Shock Diffusers for Vehicles," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7907 H

THE PROPRIETOR of BRITISH PATENT No. 129,744, dated April 3, 1918, relating to "Improvements in or relating to Tyre and like Inflating Valves," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7908 H

THE PROPRIETOR of BRITISH PATENT No. 129,700, dated June 14, 1918, relating to "Improvements in Clutch and Brake Friction Facing and in the Process of Making the same," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7909 H

PATENTS.—"IMPROVEMENTS IN PERCUSSIVE IMPLEMENTS FOR CLEANING METALLIC SURFACES." THE PROPRIETORS of O. Sperling BRITISH PATENT No. 123,055 are DESIROUS of LICENSING it to British Manufacturers on reasonable terms to ensure its manufacture and development in Great Britain, or of selling the patent outright.—For full information address inquiries to W. P. THOMPSON and CO., Chartered Patent Agents, 12, Church-street, Liverpool. P5222 H

THE OWNER of PATENT No. 129,252, for "Improvements in and relating to Method of and Apparatus for Cutting Metals Under Water," DESIRES to LICENSE or SELL the PATENT RIGHTS in Great Britain.—Address, E. P. ALEXANDER and SON, Chartered Patent Agents, 366, High Holborn, London, W.C. 1. 7866 H

THE OWNER of PATENT No. 125,284, for "Improvements in and relating to Apparatus for and Method of Burning Combustible Gases," DESIRES to LICENSE or SELL the PATENT RIGHTS in Great Britain.—Address, E. P. ALEXANDER and SON, Chartered Patent Agents, 366, High Holborn, London, W.C. 1. 7867 H

THE PROPRIETOR of the PATENT No. 167,213, for "Improvements in TOOTH-FORMING MACHINES," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to

HASELTINE, LAKE and CO.,

Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C. 2. 7874 H

THE PROPRIETOR of the PATENT No. 167,441, for "Improvements in TOOTH-FORMING MACHINES," is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCE and otherwise on reasonable terms for the purpose of EXPLOITING the same and ensuring its full development and practical working in this country.—All communications should be addressed in the first instance to

HASELTINE, LAKE and CO.,

Chartered Patent Agents, 28, Southampton-buildings, Chancery-lane, London, W.C. 2. 7873 H

THE PROPRIETOR of BRITISH PATENT No. 110,876, dated April 18, 1917, relating to "Improvements in Safety Razors," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Ill. 7910 H

PATENTS

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For continuation of For Sale Advertisements, see page iii.

MARCH.

Imperial Airship Services.

JUST in time to prevent the carrying out of the Government's announced intention to dispose of our remaining airships, an offer to take them over and use them for the establishment of an Imperial airship service was received from Commander C. D. Burney, supported by Vickers Limited and the Shell oil group. The scheme submitted contemplates at the outset a bi-weekly service to India, and later on an alternate-day service to India, with a weekly extension to Australia. The Government is to hand over free of cost the four airships in its possession, all airship material and the airship bases, to supply wireless telegraphy and meteorological services, and to guarantee—in conjunction with the Governments of India and Australia—the interest on the capital involved. The vessels taken over, it is proposed, should be used for training and short journeys only, five new vessels of 3,800,000 cubic feet capacity being constructed for regular use on the extended routes. These vessels would have a maximum speed of 70 knots, but taking the average speed at 40 knots, they would enable Bombay to be reached in 5½ days, and Perth, West Australia, in 11½. The promoters of the scheme believe that the services, after an initial experimental period, would become self-supporting, and finally show a good profit. They are not deterred by recent airship disasters, for they argue that they could have been prevented. In the case of the R 38, they say, the disaster was caused by certain errors in the design, and, moreover, the performance demanded of the ship was far in excess of that required of a commercial vessel. The Roma, they urge, was lost because she was being subjected to speed trials at a height above the ground so low that it allowed no opportunity for recovery from even a trifling mishap.

The New Waterloo.

THE work of reconstructing the Waterloo terminus of the London and South-Western Railway has been so long in hand that the former state of things is almost forgotten, and, to many, there remains only a hazy recollection of the three separate and almost distinct stations—North, South and Central. It was in 1899 that the company obtained powers to enlarge the terminus. At that time there were seventeen platform lines, of which eleven were under the roofs of the South and Central stations. It is to these roads and the platforms they served that the greatest changes have been made. There are now twenty-one platform lines, of which fifteen are under a new roof that spans the part where the South and Central stations used to be. The southern fifteen platforms vary in length from 610ft. to 860ft., whilst the northern six are from 513ft. to 615ft. long. No platform is less than 30ft. in width, and some reach 39ft. Among the outstanding features of the station are the waiting, refreshment and dining rooms, telegraph office, &c., on the north-east side, the wide concourse between them and the entrances to the platforms, and the accommodation for vehicular traffic for either arriving or departing passengers. The roof is carried on rows of columns at 60ft. centres, and as these columns are 36ft. 6in. in height, the feeling of ample space is much increased. The foot entrance near York-road has been made into a "Victory" arch, suitably decorated, in memory of those servants of the railway company who died in the war. The whole station, including the railway offices, public rooms, lay-out of the platforms and the connections outside with the eight running lines, has been admirably planned and reflects great credit on the late Mr. J. W. Jacomb-Hood and on Mr. A. W. Szlumper, his successor as chief engineer. It was formally opened on the 21st of the month by the Queen, in the absence, owing to indisposition, of the King.

European Reconstruction.

SINCE the proposals for the industrial reconstruction of Europe have taken definite form, French economists have been expressing views that coincide with those of the commercial and industrial classes generally. While in principle the French are not opposed to anything that may assist in the rebuilding of trade in Eastern Europe, they hold that the first duty is to do what is necessary for the consolidation of trade and industry at home. They are able to take up this position because the territorial acquisitions both in Europe and Africa have provided the country with additional resources that, when developed, will make it practically self-supporting. The programme of the French is to produce, as far as possible, all that is required for their own needs. They have now the most extensive workable iron ore deposits in Europe; the Saar basin has provided them with additional reserves of coal, and efforts are being made to supplement them with other home fuels, particularly alcohol and benzol, while the fuel consumption is to be reduced by an extensive utilisation of hydraulic power. The colonies are being rapidly developed by the laying down of new railways and the construction of ports, whereby it is hoped to supply the mother country with most of its requirements in cotton, wool, timber, cereals, and other produce. Projects for the irrigation of the Niger Valley for the cultivation of cotton are under consideration. In addition to these future developments there is an immediate need for enormous quantities of material for the reconstruction of the devastated areas and for the carrying out of the vast hydro-electric, railway, and other public works. With such openings for business the French believe that they are not directly interested in the industrial reconstruction of Europe as a whole if that work should entail some sacrifice in the way of diminished reparations. Their policy at the present moment is a purely national one, but possibly a give-and-take policy will ensure their participation, particularly with regard to a reform of the fiscal arrangements, which are giving satisfaction to no one, and may be adjusted in such a way as to provide much greater facilities for international trade.

Electricity Supply in the Pottery Towns.

DURING the month a further stage in the development of the electricity supply of the county borough of Stoke-on-Trent, bringing the total available load up to 6000 kilowatts, was reached. The pottery towns—Longton, Fenton, Stoke, Hanley and Burslem—were federated in 1910, and in that year the supply of electricity came under common management. In 1911 instructions were given by the Electricity Committee for the preparation of a scheme to meet future requirements, as it was evident that the existing plants could not be extended by mere additions in each works. It was recognised that a new system, capable not only of supplying the additional power required at each of the works and providing for large consumers in any part of the area, would have to be added. It was therefore decided to extend by adding to the plant at Hanley machinery for three-phase extra high-tension alternating current, and to build the necessary supply sub-stations. Beginning with two 1500-kilowatt turbo-generating sets installed in 1913, the demand for current has gone on steadily increasing, necessitating additions to the original plant, the latest of which was put into commission on the 30th ult., the total available load being now 6000 kilowatts. The most recent addition is a 3000-kilowatt three-phase 51¼-period 6000–6600-volt turbo-alternator, with surface condensing plant and switchgear, all supplied by the Metropolitan-Vickers Electric Company, Limited. Steam is provided by Stirling boilers, the most recent of them being of the five-drum type designed for a pressure of 200 lb. per square inch, and having self-contained fans and double grates. The heating surface of each of these boilers is 8282 square feet, and Underfeed stokers are fitted. According to the Electricity Commissioners' statistical returns for the year 1920–21, the central power station for the pottery towns has amply justified its existence. It was the fifth in order of merit in the 114 generating stations having an output between 5 and 15 million units, and a further extension has already been authorised. Mr. C. H. Yeaman, the borough electrical engineer, who is responsible for the design of the station, is to be congratulated upon the success that has been achieved.

Railwaymen's Wages.

AT no time during the last forty years have the relations between the railway companies and their servants been as happy as they are to-day. Why, when there is such unrest in the engineering industry, this should be so, it is difficult to explain. All that can be said is that the better feelings between the two parties began when the men turned down the proposals of the Ministry of Transport that they be represented on the directorate and accepted instead the companies' offer of Whitley Councils. The latest good result of the happier relations is that the National Union of Railwaymen has accepted the proposal of the English and Welsh companies that the Scottish wages award should be applied to the railways south of the Border. This agreement did not, at one time, seem likely, as the companies took the question to the Central Wages Board, at which there was no agreement, and it went automatically to the National Wages Board. Before a meeting of the latter could be summoned, the companies withdrew the proposition and met the men themselves. This step led to the announcement on the 18th of the month that the men had accepted. The Scottish award, it may be remembered, was that the extra pay, varying from 2s. to 7s. 6d. per week, given in June, 1920, by the National Wages Board should be withdrawn in instalments equal to the amounts of the reductions under the sliding scale, that youths should not get adult pay until twenty years of age instead of at eighteen years, and that the eight-hour day be modified so as to be spread over ten or twelve hours. The condition as to youths does not exist in England and Wales, as that was adjusted some time ago. On the 21st the Central Wages Board decided that under the sliding scale a further 2s. per week was to come off the men's pay, in addition to that named above, as from April 1st. This decrease makes a total of 15s. since April, 1921, or 17s. with the deduction agreed to on the 18th.

The British Industries Fair.

THE eighth annual British Industries Fair, which closed on the 10th of the month, was this year divided into two parts, opened at the same time in London and Birmingham. The London exhibition, which was held in the White City, Shepherds Bush, was devoted chiefly to light manufactures, textiles, &c., but that at Castle Bromwich, Birmingham, was largely composed of engineering products. There was, as would only be expected, a large proportion of that class of hardware for which the Birmingham district is famous, but the exhibits were so grouped that the various classes of manufactures were fairly distinct, and the building devoted to engineering products housed a good representative display. It was noteworthy that small gas and oil engines, often direct coupled with dynamos, were much in evidence, while the heavier class of electrical machinery was almost entirely absent. Welding equipments, both electric and acetylene, were also to be found in considerable numbers. Apart from these two types, it could not be said that any class of machinery was more prominent than another, although the exhibits ranged from small hand tools to heavy hydraulic presses, and included such specialised examples as needle pointing grinders and nail-making machines. The attendance at the exhibitions, which comprised only prospective buyers, the general public not being permitted to pass the turnstiles, included a number of visitors from overseas, and its extent showed that the value of the Fair is recognised far and wide.

Railway Amalgamations.

THE greatest event of the month in the railway world was the announcement on the 18th that the London and North-Western and Midland companies had come to terms for their amalgamation under the Railways Act. Early in February an announcement was made that the negotiations had made such progress that the news of an agreement might be expected any day. In railway circles, however, that announcement was not credited, and the news that the terms had been agreed came as a surprise. The two companies are to be amalgamated into a common concern—having a name yet to be determined—as from January 1st next. There yet remain the North Staffordshire and the Furness among the English companies to be amalgamated with the London and North-Western, Midland and Lancashire and Yorkshire—the last ceased active life on December 31st—and the three Scottish companies, the Caledonian, Glasgow and South-Western, and Highland. On the 20th the Railway Amalgamation Tribunal approved of the scheme whereby the Alexandra Dock, Cambrian, Cardiff, Rhymney and Taff Vale railways will be amalgamated with the Great Western. That amalgamation is to date from March 25th, but the amalgamation under the Great Western Group will not be complete until approval has been given to the terms with the Barry, which have not yet come before the Tribunal. On the 27th the Tribunal approved of the amalgamation of the Hull and Barnsley with the North-Eastern. It dates from April 1st.

The Loss of Submarine H 42.

AT 9.30 in the morning of the 23rd of the month the British submarine H 42 was rammed and sunk by the destroyer Versatile, with the loss of all hands. The submarine was engaged in exercising off Europa Point, Gibraltar, and it appears that she came to the surface but a few yards ahead of the destroyer, which was steaming at 20 knots. There was no time to alter the course sufficiently to avoid a collision, and the submarine was struck at right angles just abaft the conning tower. The H 42 belonged to Portsmouth, and was attached to the submarine depôt ship Maidstone. She was a vessel of 440 tons surface displacement and 500 tons sub-

merged, her dimensions being 171ft. long overall, beam 15ft. 6in. and draught about 14ft. She was built by Sir W. G. Armstrong, Whitworth and Co., Limited, in 1918, and her engines were constructed by Ruston and Hornsby. Her surface speed with 480 horse-power was 13 knots, and submerged with 320 shaft horse-power she could make 12 knots. She had on board her at the time of the disaster twenty-six officers and men.

French Railways.

THE reports of the French railway companies issued during the month afford interesting reading in the light of the efforts being made in France to develop transport to the best advantage of manufacturers and other users. The reorganisation of the entire railway and inland waterway systems is regarded as of the first importance to the country's welfare. The two chief ends in view are to convey raw material to the consuming centres as cheaply as possible and to carry manufactured products to the frontiers and ports for shipment at the lowest cost, and also to divert through France the traffic between Central Europe and countries overseas. As is the case in most other countries, the railway companies have suffered severely from the financial upheaval, and fares and rates have had to be increased, although not to the extent that would seem to be justified by the situation of the companies. It was in the belief that an advance in rates would have the effect of lessening traffic and diminishing receipts, and thereby making the position worse, that the Government decided to put all the railways under one administrative control with the idea of suppressing useless expenditure, standardising the service as it were, and running all the systems under conditions of greater economy. The Superior Railway Council has come into being with promise of doing great things for the development and improvement of the railway service, but time alone will show whether this somewhat unwieldy body will entirely fulfil expectations. As the Council is representative of all the railway interests, as well as of every class of users, it becomes a sort of railway parliament which will decide upon every question affecting transport as well as upon the expediency or otherwise of the many vast works the companies propose to put in hand. A beginning has been made with the electrification schemes which are already well advanced on some of the lines, and, while the Midi is to be almost entirely electrified, the line from Paris to Orleans is to be equipped electrically, while around Paris steam locomotives for suburban traffic are destined to disappear.

The Condensing Locomotive.

RAILWAY engineering was very much to the fore during the past month, owing to the discussion on the comparative merits and demerits of British and American locomotive practice at the meetings of the Institution of Mechanical Engineers. Further interest was added by the publication in these pages of a description of the principal features of a new turbo-electric condensing locomotive, which has just been completed at Armstrong, Whitworth and Co.'s works at Newcastle-on-Tyne for the Ramsay Condensing Locomotive Company. This remarkable engine has now gone to Horwich, where it will be tested under practical running conditions. Mr. Ramsay, the inventor, claims that his locomotive combines the advantages of the purely electric locomotive with that of the steam locomotive, while effecting considerable economies in the amount of fuel and water consumed compared with the latter. Although such an engine could hardly compete with the electric locomotive for short local services, for long-distance runs, and especially in countries where economy in the use of fuel and water is particularly important, the condensing locomotive possesses obvious advantages, and the results of the tests which are now being carried out will be looked for with much interest by all who are concerned with locomotive practice.

The Shirley Institute.

As an example of what can be done by co-operation in scientific research, the Shirley Institute at Didsbury, near Manchester, which was opened during the month, will compare favourably with any corresponding institution in the kingdom. It owes its origin to meetings held in Manchester, during the period of the war, at which it was generally agreed that many investigations were needed in the cotton industry, and that any extensive system of research necessitated an improvement in the facilities for education. As the result of these meetings, it was decided to form a body called the British Cotton Industry Research Association, membership of which would be open to British corporations and firms engaged in any of the branches of the cotton industry and to corporate federations. Whilst realising that individual effort in research should be made use of as far as possible, it was felt that the desired results would only be forthcoming when the chemist, the colloidal chemist, the physicist, the botanist, the technologist and the engineer were brought together under one roof as a body of workers co-operating under the guidance of a director. It was therefore decided to acquire a house and 14½ acres of land at Didsbury. The house has been adapted to the purposes of administration and to the library, and laboratories have been built on the estate. These laboratories are devoted to botanical and bacteriological research, physics and chemistry. The great importance of the subject of "colloids" for the cotton industry is recognised by the creation of a separate department with all the necessary appurtenances for research under the best possible conditions. Such an institution furnishes a link between the universities and the cotton industry which has not hitherto existed, and the effects of the research work carried out in it can scarcely fail to prove of substantial benefit to the cotton industry of this country.

The Engineers' and Shipyard Disputes.

WHEN the month opened there was a strong hope that means might be found to reconcile the disputes in the engineering industries. Although negotiations had been broken off, the Minister of Labour was able to bring about their resumption, and on the 9th inst. a new conference between the Employers' Federation and the A.E.U. took place. The union representatives presented and explained their proposals, but after a prolonged sitting the conference terminated without any settlement being effected. In the opinion of the employers it appeared to be clear that any restrictions which the unions had been able to impose, in relation to managerial acts in engineering establishments, as a result of the abnormal conditions during and since the war, would be insisted on, and the union's proposals were therefore not acceptable. At this conference the question of overtime was not discussed, the whole time being spent in the discussion of the principle at issue. The breakdown of this conference on the eve of the termination of the lock-out notices made the lock-out of A.E.U. members unavoidable, and besides tending to extend the dispute to other amalgamated unions, it incidentally had the effect of adjourning a conference on the shipyard wages cut. With the commencement of the lock-out on the 14th inst., some 250,000 skilled engineers were thrown out of employment. As the lock-out proceeded, manifestos were issued by both the employers and the union representatives, setting forth their views on the exercise of managerial functions, dual control, overtime, and the manning of machines. Efforts were again made to bring about the resumption of negotiations, and it was suggested that the Minister of Labour should institute a court of inquiry into the causes of the dispute. Such a procedure, it was felt, could not do other than delay a settlement, and this course was not favoured by the Government. On the 21st inst. a debate on the industrial situation took place in the House of Commons, when Mr. Clynes presented the case for the unions and Sir Allan Smith spoke on behalf of the Employers' Federation. The speech of the latter member—in which he said: "The employers were ready to say to the men now balloting that if they were ready to agree in principle that the employers had the right to exercise their own managerial functions, the employers would be only too pleased to sit down at a conference while the men were working, in order to come to an agreement with them as to the vexed question of how managerial functions were to be operated"—was the means of bringing about an informal meeting between Sir Allan Smith and the National Joint Council of Trade Unions, which acted as a mediatory body. After a preliminary meeting, and in spite of an adverse vote with a majority of 115,256 against the employers' terms, a basis for discussion between the unions and employers was arrived at, and a conference arranged for Tuesday, the 28th. It also failed, owing to the demand that the locked-out members of the A.E.U. should be reinstated. On the 29th lock-out notices, to take effect on the 6th inst., were posted by the employers to the members of the forty-seven other unions besides the A.E.U. which had refused to accept the employers' original terms. In the case of the shipyard wages ballot, the revised offer of the employers to effect this reduction in instalments of 10s. 6d. on March 29th and a further 6s. at the end of April, was after some discussion referred to the various unions for a new ballot. Thus the month ended with no settlement made in the case of either dispute.

Chinese Engineering Notes.

(From our own Correspondents.)

Peking.

BUSINESS with the Chinese Government has been at a standstill for so long that certain junior Chinese officials have been getting rather hard up, and have been putting their heads together with a view to making up for the commissions that would have been forthcoming had the various Government Departments been purchasing materials from foreign countries in the usual way. The Government has been so short of funds during the last year or so that it has had practically nothing to set aside for such things as railway supplies. All the revenue from the railways, after paying interest and redemption on the bonds, has been spent on the maintenance of China's rabble army. The navy does not count in China. None of these officials, either afloat or ashore, have been paid for six months, and there seems little likelihood of their getting any money in the near future. But to return to the junior official in Peking who has suffered as a result of no foreign orders being placed. Recently the position became so acute that two such officials evolved a really good "get-rich-quick" scheme. During the past year, at the request of the railway authorities, practically all the representatives of foreign engineering firms have put in tenders for various railway supplies. Last week two Chinese set forth from one of the Government railway offices with signed contracts in their pockets. One called on the French and Belgian firms and the other on the British and American firms. They informed the various firms that their tenders had been accepted on the prices quoted, and handed over the signed and sealed contract, casually mentioning that they presumed the prices included the usual commissions. This was true in most cases, and the foreigners concerned being so overcome at having received an order at last—some of them had never received an order before—promptly handed over the commission to the Chinese. Three days afterwards it was discovered that the contracts were forgeries, and that the two Chinese had disappeared richer by over £25,000. It is reported that one of the contracts was for 1000 bottles of whisky, and not only did the firm pay the "squeeze," but delivered the goods!

Considerable feeling exists in Peking amongst the representatives of the British armament firms at the continued violation of the "Arms Embargo" by certain of the other parties to the agreement. In spite of this agreement, the nationals of one of the parties are supplying large quantities of arsenal equipment to one of the Tuchuns (military governors). The contract calls for the complete equipment of a large arsenal, and the amount involved is well over £1,000,000. The contract was signed as far back as October last, but it was hoped that sufficient pressure would be brought to bear by the other Powers to get it cancelled. However, it is now reported that a large portion of the equipment is on its way out, and naturally the British firms interested in this class of business feel very bitter about the affair.

Shanghai.

Having indicated the possibilities of trading in China, it would be well to know how to trade with China. And to trade with China involves special difficulties. It is easy to go to the savage of, we will say, mid-Africa or mid-Borneo, and please him with a novelty in the shape of braces and create a demand for braces by missionary effort. It is also comparatively easy to convince a hard-headed Westerner of the desirability of acquiring a contrivance which you can prove to him will save him money. But the Chinese are neither savages nor hard-headed Westerners; they require no braces, having long outstripped civilisation in discarding those cumbrous appendages; they do not require a contrivance to save them money, as they have reduced economy to an obsession. To sell anything to a Chinese, one must convince him that he is going to make money in actually making the purchase. In other words, get a brokerage right at the start, and as an enterprise is seldom started by a Chinese single-handed, the secret of a successful deal in China is to be able to discover the party in the combine who has most influence with the others, and arrange terms with him, whilst you are munificently entertaining the others. This procedure really only amounts to the merchant purchasing the moral assistance of the party in the combine, to the latter's ultimate good, if the purchased machinery is reliable.

A plough cannot be made and imported to compete in price with the native-made wooden one, which is lashed with rattan and has no metal about it except the cast iron shoe, or a weight-lifting machine to compete at present in price with the labour cost of coolies who will lift anything. The chance for the sale of western machinery will come when the Chinese realise that time means money.

The braces of Western civilisation are replaced in China by bands of cloth wound round and round, and they take time to adjust. The coolies can lift a boiler out of a ship on to the wharf, and along the shocking roads to its seating, but it takes time.

We must therefore give the Chinese a reasonable

sense of their own importance, so that they realise five minutes of their time is worth something, and the way to do that is to provide them with railways and roads. The railway train is a great educator in the value of time, and it reads its lesson to rich and poor alike, as both have to use it on the basis of a timetable. We Westerners are so used to it that we forget what it has taught us.

Business is very often lost in China by reason of the fact that the agent handling the deal for the home manufacturer has no opportunity of discussing the matter with the home manufacturer during the negotiations for the business with the Chinese. The agent has his hard-and-fast quotations and terms of payment, and these he cannot vary without affecting his share of the profit. A direct representative of the home manufacturer, with full authority to act for the best in the interests of his firm, would not be affected by this, and with his intimate knowledge of home manufacturing costs could secure business which would be impossible to the commission agent. Another fact is that the manufacturer too often gives his quotations on the basis of ex factory or f.o.b. The Chinese want to know what they have to pay at the Chinese port; f.o.b. prices mean nothing to him. The direct representative could approach the Chinese buyer with a price approximating to that of his competitors, and when he feels that the time for placing the order is approaching, he could probably secure the business if he were able to change his terms slightly and without delay. The negotiations will have been proceeding possibly for weeks or months, and the culmination will be often reached after a protracted feast and patient display of good fellowship, and it is then that the slight concession will count, and put the "chop" on the deal.

Engineers resident in China are supplied with excellent catalogues by the home manufacturers, and these engineers know the reliability of the machines shown, and the pictures and information given in the catalogues interest the progressive Chinese immensely, but it all seems like a dream to him, and as he feels himself incapable of running the fantastic contraption, he reluctantly contents himself with the old methods of getting results.

However, as has been said before, China is waking up, and by combining British with Chinese capital and British engineering skill and Chinese needs, the resources of this country would be developed to the betterment of world trade and world peace. In Shanghai there are over one million spindles working cotton and half a million are projected. In the Shanghai International Settlement some £3,750,000 worth of building construction was put in hand last year. These figures are merely indicative of the field which is open to home manufacturers for the supply of machinery, hardware, &c. &c. But the larger field opens when the financiers of Great Britain join hands with the financiers of China, and arrange to construct railways, roads and wharves with the latest modern equipment.

Conservancy Work in South China.

One of the first impressions of the visitor to Hong Kong and South China is the contrast between the engineering activity obvious in the British Colony and the almost entire absence of such activity in the rest of South China. It is true that ten years ago this contrast was more marked than it is now. Although "old China hands" say that nothing changes in China, yet it is a fact that twelve years ago there was not a road in South China, outside of Hong Kong, fit for any wheeled vehicle, and for all except about one-tenth of 1 per cent. of the traffic they are no better to-day. But a change is coming. In Canton, the capital of South China, a city of about 2,000,000 inhabitants, there were, in 1918, huge city walls. Two or three years ago those walls were doomed and have since disappeared, and roads suitable for wheeled vehicles have been built on the old foundations.

Kwangtung Conservancy Work.—About seven years ago the Board of the Conservancy Works of Kwangtung, one of the eighteen provinces of China, was formed. This province adjoins the British territory of Hong Kong. It contains a remarkable population; industrious, ingenious, and invariably possessed of great commercial acumen. The natives are called Cantonese, and they have emigrated to Singapore, Straits Settlements, Java, Siam, &c. They are the merchants and the agitators of the new China. The main support of Kwangtung is the land, and rice and mulberry trees are the most valuable crops. The population of the province is about 30,000,000. There are three main rivers, called the West, the North and the East. For seven years the Engineer-in-Chief of the Board of Conservancy Works of Kwangtung, Major Olivecrona, and his staff have been accumulating data, and carrying out such work as the limited funds at their disposal permitted. They have evolved various projects, and their annual report for 1920 has just appeared. It is stated therein that the works essential to a complete flood protection in the West, the North and the East river valleys and the Canton Delta are spread over an area with nearly 9,000,000 of inhabitants, and that the district is penetrated in an amazing manner by a large number of natural waterways.

It may be mentioned that, in addition to these land inhabitants, there must be in South China millions of people who pass the whole of their lives on small boats, which contain often a family of three generations. They live and die on these "Sampans."

The 9,000,000 people affected by the floods pay two taxes, the field tax and the rice tax; and the annual payment for the year under consideration was about 6d. per head of population. Major Olivecrona proposes to increase the field tax and so raise about 3,000,000 dols. (Hong Kong currency) per annum for flood protection works. He estimates, however, that to complete the work in five years would necessitate a yearly expenditure of 7,000,000 dols., and he appreciates the fact that such a sum can be obtained only by means of a loan. That the work will be productive, and that therefore the loan is quite a sound scheme financially, can be proved by the technical men. The real difficulty is the disturbed state of Kwangtung politically. That is the difficulty all over China to-day. Everywhere engineering work is being retarded and hampered because of the political chaos which obtains in almost every one of the eighteen provinces.

However, work does progress in Kwangtung, in spite of the robbers, pirates and soldiers. The Board of Conservancy gives an excellent and concrete example of the reproductive nature of the engineering works which it has carried out. "With an expenditure of 25,000 dols. for three dams across three branch channels of the East River, we unwatered an area sufficiently extensive to reap an increase of over 600,000 dols. in one season. The increase will be recurrent yearly hereafter. There is no reason why we should not expect similar results from other reclamations, and the earlier the start, the sooner will benefit be reaped. Of course, the progress of our work depends primarily on the funds available." So writes the Chinese official, Sun Fo, who is the Director-General of the Board of Conservancy Works of Kwangtung.

During the year under review, the revenue of the Board was about £60,000, and of this, about 95 per cent. was provided from that true friend to China, the Maritime Customs service. The Canton Municipality has given a suitable piece of land, and a well-known firm of Hong Kong architects and engineers is constructing offices for the Board in Canton. The old ancestral hall, which now houses the valuable records of surveys, plans, &c., will be replaced by a structure of a very different type.

The Cost of Labour.—Last year on the East River the total earthworks executed amounted to the removal of 1,102,326 cubic metres of earth for the reconstruction of 21,052 m. of dykes. Last year the earthwork was done on contract pay, instead of on day wages. The contract pay varied between 17 and 25 cents (or, say, 5½d. and 8d.) per cubic metre. There were many cases of obstruction. The report says: "Without the support of police force, it will be impossible for the engineers of the Board to execute work on sound technical lines when obstruction is met from the villagers." The opposition is largely due to ignorance.

Another fact mentioned in the report will be of interest to the works manager and the economist in England. Some difficulties have been experienced this year in persuading the country people to undertake earth excavations at reasonable wages. Often the reply was that the last year had been so prosperous for the farmers that they had no need to submit themselves to tedious labour. It is encouraging to hear that the work of the Board has effected such a great improvement in the actual conditions of living; but, on the other hand, the increase in wealth of the farmers will also increase the cost of future works.

On the North River, dykes have been reconstructed and work on the Lupao sluice put in hand. Three new steam pile-driving plants have been ordered from abroad, and Ransome and Rapier, Limited, of London, have sent out the main part of the iron shutters for the Lupao sluice gate. The total cost of this gate for the year was 235,475 dols. (or about £30,000). Although a great deal of the expenditure of the Board goes in wages, it is quite evident that if the work is carried out on the scale necessary and contemplated, machinery and ironwork from abroad will be obtained.

Technical men in China are really trying hard to carry out the transformation of that country which is essential if the calamities of the past are to be avoided in the future. The politician and the soldier have been the curse of China for centuries. If the engineer has half a chance, he will at least save life and prevent the present horror of perpetual starvation from terrorising the vast majority of the agricultural population; and perhaps he will be allowed to release the mineral wealth and increase the volume of trade, which will benefit, not only China itself, but the whole world.

It is estimated that there are now more than two hundred firms publishing their own magazines in this country. They include engineering firms of all kinds, iron and steel manufacturers, shipbuilders, flour millers, foodstuff manufacturers, collieries, banks, textile firms, railways and distributing firms. The Industrial Welfare Society is now arranging the second of a series of annual conferences of the editors of such journals, which is to be held in the Society's offices at 51, Palace-street, Westminster, on Friday, April 28th.

British and American Locomotives.

Mr. Dewhurst's paper on "British and American Locomotive Design and Practice" was read in abstract before the North-Western Section of the Institution of Mechanical Engineers by Sir Henry Fowler, on Thursday, March 23rd. There was a very good attendance, and the discussion which ensued showed that the paper was of more than average interest.

In opening the discussion, Mr. S. Jackson said that he entirely agreed with the author in his remarks upon the non-flexibility of the bar frame; undoubtedly the plate frame as cross stayed by British designers was more flexible laterally than either the bar frame or the plate frame with continental type of bracing stays. He was rather surprised to note Mr. Dewhurst's claim for popularity of the American locomotive on the score of compensating gear in the spring rigging. Complete compensation of the spring gear to give an easy riding engine, as also the use of flangeless wheels for ease on curves, had been standard British practice on foreign engines for upwards of fifty years. Spring compensation was quite common on British railways in the early days, but with the development of well-laid tracks, compensation fell into disuse. With regard to boiler capacity, he did not think the modern British-designed engine was deficient in this respect. The author mentioned Walschaerts' valve gear as being the standard for American engines, and it was interesting to note that this gear was standard for British-designed foreign locomotives having outside cylinders with valves on top for at least twenty years before the Americans discovered it, along with the Mallet compound, in 1906. Locomotive designers and builders in this country were only too pleased to embody in their designs any structural or detail improvements which colonial or other requirements had found advisable, and the speaker thought it could be safely said that most of the outstanding improvements in locomotive design had originated either in this country or on the Continent, whilst the well-known articulated engines—the Fairlie, Meyer, Mallet, Kitson-Meyer, and Garratt—were invented and perfected in Europe.

Mr. A. E. Kyffin pointed out that most of the special features of American engines mentioned by the author were incorporated in many of the British locomotive firms' designs for overseas railways, even to the extent of bar frames. As to boiler power, he contended that American boilers perhaps had an apparent advantage as they were normally designed for burning coal which was inferior to British, but it would be found that if fuel quality, &c., was known, the capacity of British designed boilers was ample.

Mr. G. O'Brien said that he was astonished to find Mr. Dewhurst rather half-hearted about the four-cylinder engine after the success attained by that type, both in Great Britain and on the Continent, particularly as a four-cylinder design was essential in order to obtain the maximum tractive effort permissible within the British loading gauge. Three 21in. cylinders were the maximum permissible with the three-cylinder design, whereas the four-cylinder permitted of four 20in. cylinders, and a boiler of sufficient capacity for them was just obtainable within the British loading gauge. All locomotive engineers would appreciate the better support given to the axle boxes by the bar frame, but in actual practice loose hornblock bolts did not occur in sufficient numbers to be any real trouble. The author did not mention the all-bronze axle-box. That type, though expensive in first cost, was actually the cheapest to maintain. In respect of fire-boxes and internal main steam pipes, the author expressed a preference for copper as against steel, which was amply justified by facts. As regarded tubes, on the other hand, he preferred steel. As a matter of fact, opinions as to the relative merits of the two materials for these purposes were not worth much. A properly drawn up financial statement, based on known data, was the only basis on which an opinion could be formed, and that opinion might require much modification under a different set of circumstances, the quality of the water on any particular railway being a deciding factor.

Mr. J. W. Smith questioned whether, except for special traffic, it would be practicable to make profitable use in this country of locomotives as large as those which were used in America. The hauls in this country were comparatively short, and the traffic on the British lines was considerably denser than in America. What was demanded in this country was a quick and frequent service. That fact was often overlooked when making comparisons between British and American locomotive requirements. He was inclined to believe that if the railway companies in America built their own engines and repaired their boilers to the same extent as was done in this country, they would have changed from steel to copper for fire-boxes. With regard to tubes, in recent years many of the British companies had replaced copper tubes by steel. The company with which he was connected had practically all its engines fitted with steel tubes. The usual British practice was to fit copper pipes. A number of locomotives of which he had knowledge were fitted with steel main steam pipes, but they gave so much trouble

by corrosion and pitting, that they were replaced by copper.

Mr. E. M. Gass noted that the author suggested, on page 3, that a much greater use could be made in this country of powerful eight-coupled engines, or even of ten-coupled. There were numbers of the former running in this country, but none of the latter, with the exception of probably the Midland engine employed on banking. The non-use appeared to lie in the fact that it was difficult to obtain sufficient adhesion, and at the same time keep the weight below the engineer's standard curve for underbridges, on the assumption of two of these engines being coupled together, each having a tender capable of carrying 4500 gallons of water and 6 tons of coal. Taking an axle load of 16 tons and a coupled wheel base of 22ft., which was about as short as it could be in order to get in the necessary brake blocks, it was found that the equivalent uniformly distributed live load per foot run was above the bridge curve on spans of 30ft. to 80ft. The largest diameter of outside cylinder that could be employed on a load gauge of 8ft. 8in. wide was 19in. Assuming the engine to be equipped with four cylinders of this diameter, a piston stroke of 26in., a wheel diameter of 4ft. 6in., and a boiler pressure of 180 lb., the tractive effort at 85 per cent. of boiler pressure was 53,187 lb. To absorb this tractive effort, the weight upon the rails, on the assumption that the adhesion was 25 per cent. of the total weight, was approximately 95 tons, or 19 tons per axle, yet 16 tons per axle was not allowable on short span bridges. Respecting boiler power, the best proportion of grate to heating surface appeared to be in the neighbourhood of 1 to 60, making the grate area for four 19in. by 26in. cylinders approximately 50 square feet. A grate of that capacity arranged between the frames was not practical, as it meant a fire-box length of about 15ft., so the wide box arranged above the wheels had to be resorted to, and this, in turn, resulted in a shallow fire-box with restricted volume, and little depth between the grate and brick arch for the coal bed. Hence, it would be seen that the difficulties that presented themselves in designing high-capacity ten-coupled engines that conformed to the British load gauge and standard curve for underbridges were (1) axle load limits, and (2) ample fire-box volume.

Mr. J. R. Billington said that Mr. Dewhurst had not made the matter of plate frames *versus* bar frames quite clear. It was not so much a matter of rival design, as of an adaptation to circumstances, in the first place, and afterwards one of growth and development. Going back to the early days of locomotive building, the first locomotives were made in this country with plate frames and fire-boxes between the frames; but on account of the heavy freightage which the Americans wished to avoid, they started with bar frames which they could make in their own country, as plates had not been rolled in America in the early days of the locomotive. Subsequently, with the large fire-boxes that were required in America for the poor fuel and rapid growth of locomotives, the bar frame was well adapted. Also, in the British Isles the richer fuel practically necessitated copper boxes which were, of course, smaller, and which the plate frame was also well adapted to receive.

Mr. D. Adamson said, with regard to acid steel plates and basic steel plates, that in the latter there was always a doubt as to whether the steel was of the high quality necessary, variations occurring even in one ingot when manufactured under this process. Acid steel was much more reliable, as the material was bound to be of good quality before the process was begun. When he first visited America, he had been surprised at the method obtaining there of punching tube holes in plates for locomotives, and although these were rimered out afterwards, that method compared badly with ordinary British practice.

Sir Henry Fowler said, with regard to basic and acid steel, that he was not in agreement with the author of the paper. If basic steel were properly made it was quite as reliable as acid steel. It was the trouble that so frequently occurred in the making of the ingot that had discredited basic steel. British engineers' slowness in perfecting basic steel was to be regretted, as there were many ores available in England for that material. With regard to copper fire-boxes and tubes, they had had to use steel fire-boxes during the war, but had replaced them with copper ones as soon as possible, as the latter lasted about twice as long as the former. His experience on the Midland Railway was in favour of copper tubes also. Out of 3000 locomotives, only about a quarter had steel tubes. He did not think brass tubes were used to any extent in England.

Mr. Gresham remarked on the author's statement that his experience was altogether in favour of the American form of injector, and that the British combination injector was quite unsuitable for colonial use. Without comparing the practice or theory of the American and British types of injectors, he explained some of the advantages of the British combination injector.

In a written contribution read by the hon. secretary, Mr. John G. Robinson described how the expanded joint used in his type of superheater came to be used. Expanding the units into the header amounted to nothing more than expanding a boiler tube into a tube plate, which was common practice everywhere, the important difference being that a boiler tube had to be expanded into two tube plates, and was therefore subject to expansion and contraction forces, whereas the superheater unit was free to expand and contract without restraint. It might interest the members to have some information as to the results obtained by headers with expanded units in practice. On the Great Central Railway there were 405 engines so fitted, and so satisfactory was the expanded system that the cost of maintenance had been reduced to practically nothing, and only in cases in which it was necessary to remove the units for boiler examination had they had to take them from shop to shop. Extraction of the units was quite as easy as expanding them in place, the process only reducing the thickness of the tube slightly. In point of fact, there were cases in which units had been expanded and extracted as many as six times, and were still in service. For example, the mileage per set of units in a 4–6–0 engine was found to have been 370,448 for a life of 9 years 3 months, from which it was evident that they must have been removed and replaced several times for re-tubing and examination. Almost identical figures were given by the 4–4–0 express passenger and the 4–6–2 passenger tank engines, and in the case of the 2–8–0 mineral engines a mileage of nearly 200,000 for 9 years 6 months was realised. Mr. Robinson said that when he began to fit superheaters on the locomotives, he also supplied dampers worked automatically by the pressure in the steam chest, and he, along with others, was of the opinion that they were necessary to prevent damage to the unit ends when running without steam, but he had now given them up, and fitted instead a discharge valve of large capacity worked positively from the regulator handle, so arranged that the valve closed on opening the regulator, and opened widely when the regulator was closed.

Utility Arc Welding.

We have found it somewhat difficult to choose a title for the following article, so as to convey, in a few words, a comprehensive idea of the matters with which it deals. In it we describe what has been accomplished by a small engineering firm in the way of making, by means of arc welding, things that it required, or doing work which it wanted done about its shops, using for the purpose material which it had to hand—sometimes odds and ends of scrap—with a considerable saving in time and money in every case. We had had brought to our notice, by one who is in no way connected with the firm saving as a customer, that the Foster Engineering Company, Limited, of Morden Works, Wimbledon, had for a good many years been accustomed to employ electric welding for such purposes. The practice had gradually developed because it was found that not only did it save money, but also that it enabled the articles and machines—for its usefulness includes also the production of special tools—to be made quickly and in a form particularly suitable to the firm's requirements. Our request to be permitted to inspect the works, with a view to seeing what had been and was being done was readily and courteously granted, and we have taken advantage of the permission to make several inspections. As a result of what we have seen, it has occurred to us that there must be in the country numerous firms of the size and type of the Foster Engineering Company, which employs, we believe, some 200 hands, and probably larger undertakings as well, which would benefit considerably if they, too, adopted the methods, or some of them, which that firm has employed to meet its needs. Many quite small firms even now possess arc-welding plants, and we fancy that a great many more would instal them if they know of what general utility they could be and how much money might be saved in many directions simply by doing "odd jobs" about their shops.

There is, as a matter of fact, hardly anything—in a small way at any rate—which involves the joining together of pieces of steel or iron that cannot be done effectively and cheaply by arc welding. The first cost of an arc welding plant would in very many cases be paid for in money saved in a comparatively short time. This we do not think is in any way overstating the case, as is proved by the figures of costs of work which we give later in this article.

FIG. 1—WELDED PULLEY CLIPPED TO SMALLER PULLEY

The directions in which the Foster Engineering Company has employed what has been rather aptly described as "the iron workers' gluepot," are very varied. For instance, it had, say, a hacksaw, which with its own pulley and the pulley which happened to be on the line shaft opposite the place in which it was convenient to put the machine to work, ran too fast. It proceeded at once to make a pulley of suitable size which could be clipped on to the spokes of the existing pulley on the saw. The original pulley was 12in. in diameter; the new pulley was made 17in. in diameter. The method of manufacture was as follows:—First of all, a circular disc, $16^{13}/_{16}$in. in diameter, of $^{3}/_{32}$in. steel plate, was marked out and cut. A central hole, about 2¼in. in diameter, was also cut out for the boss of the old pulley to project through. Two other holes, the purpose of which will be explained later, were also bored in the disc. Then a strip of $^{3}/_{32}$in. sheet steel, 4in. wide and of a length sufficient to make, when passed through a set of hand rolls, a cylinder with an outside diameter of 17in., was cut. The two ends of this strip were then brought together and arc welded. The disc was then placed inside the cylinder and arranged centrally in its

FIGS. 2 AND 3—STEEL PLATE DOOR IN WELDED FRAME, AND ONE OF ITS HINGES

width all round, and the periphery of the disc was welded all round inside on one side only to the internal periphery of the cylinder. Then a strip of thin sheet steel, 1in. wide, was wrapped round the centre of the outside face of the cylinder and welded in position. Finally, four small bits of light angle iron were welded to the disc in such positions that when the larger pulley was put beside the existing pulley, they embraced the external rim of the latter and made it sure that the larger pulley would assume its correct position. The new pulley was clipped to the spokes of the pulley on the machine by means of two hooks with screwed shanks, the latter passing through the two holes in the disc above mentioned, and clamped in position by nuts—see Fig. 1.

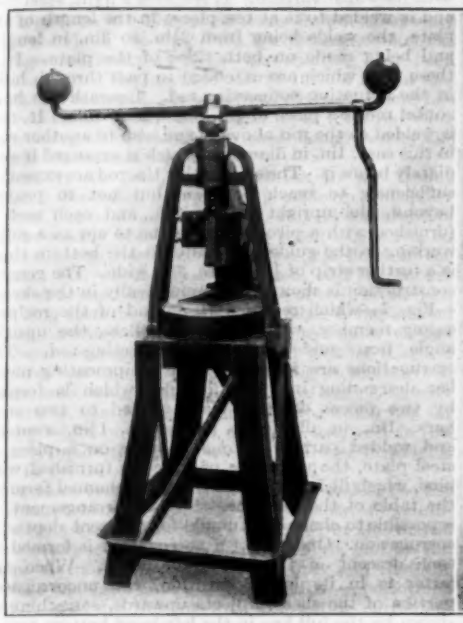

FIG. 4—STRENGTHENED FLY-PRESS

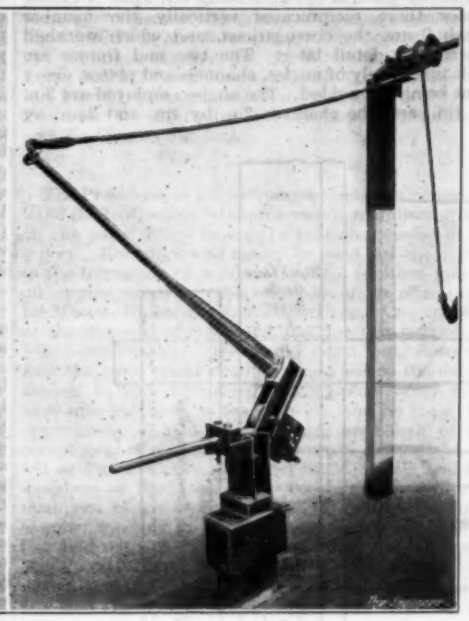

FIG. 5—BUILT-UP PIPE BENDING MACHINE

The foregoing is an example of what we intend to convey by our title. The need of the pulley was discovered, and we are absolutely assured that in less than 2¼ hours afterwards the new pulley had been made and was in place doing work. A regular pulley of the desired size was not in stock; so the decision to make a substitute was arrived at and acted upon. The pulley was made throughout in two hours by a lad earning 11d. per hour, at a total cost for labour and materials of 4s. 8d., and it is doing its work, beside numerous other pulleys which have since been made in the same way.

The remarks may possibly be made that it was a parallel pulley, and that there might therefore be difficulty in keeping the belt on. As a matter of fact, the thin strip of sheet steel welded all round in the centre of its external face has the same effect that a rounded pulley face would have, and there is, as we can testify, no trouble with the belt. Perhaps, too, the remark may be made that such a job would not look pretty; as a matter of fact, unlike some of the other examples of "utility welding" about which we propose to speak, the pulleys are by no means ill-looking. But, after all, even if they are not exactly handsome, they do the work required of them most effectively, and they are amply "good enough."

Again, the firm has circular heating stoves in its shops, and the idea struck the manager that if he were to construct water jackets to go round them and fitted a tap at the bottom of each, the operatives would be able to have hot water whenever they wanted it without materially, if at all, interfering with the heating effect of the stove. A trial jacket was accordingly very easily and quickly put together from odd pieces of sheet steel by means of the electric arc and slipped over the stove. It was found to work so well that all the stoves were treated in the same or similar fashion. In one case, the jacket was built round the flue from the stove, with quite good results. In another case—it is in the office—a light tank was built to abut against the back of the stove, with the result that the office staff always has hot water. As a matter of fact, in this case two purposes are served, for the tank comes between the stove and a wooden partition, so that the latter is well protected from heat. The taps were all that had to be procured specially, and as almost anything will do for the job, several odds and ends taken out of stock were found to answer the purpose. The ability to obtain hot water resulted in the request for portable washing bowls and water cans; both were cheaply and quickly made from scrap material.

Then, too, the firm had a hole in a wall that it wished to close with a steel plate door. The frame was made of odds and ends of angle iron or of strip. If the scrap heap did not contain pieces that were long enough, two or more were welded together. The same lad who made the pulley could do the work well and quickly at very small cost. The plating, too, could be done with scraps of sheet, so that there is no necessity to go to the expense of cutting up a new sheet. The pieces of sheet are welded to the frame. In the particular case in point, it so happened that all that was handy in the way of suitable hinges were two which had at some time or other been taken off a wood door. There was no need to go to the trouble of boring and tapping holes, the hinges were just placed correctly in position on the door and welded there.

In another case, a stout steel door was required to close the chamber containing the transformer which supplies the works with current. How it was made is shown in Fig. 2. The frame was composed of steel channels built into the wall and welded where they came together. The door, which is of thick steel plate, is all in one piece. It, of course, had to be specially procured. The hinges—see Fig. 3—were manufactured from stock stuff. The circular portions are made of 1½in. mild steel bar. They were cut to double lengths, then bored for the pins and then cut in half. Each was then welded to its appropriate plate. The door was then carefully wedged in position, and the three hinges, after having a straight rod pushed through them, were also adjusted in the positions which it was desired they should ultimately occupy. They were then welded to door and frame. The rod was afterwards withdrawn, a hinge at a time, and its place taken in each hinge by a pin, the lower end of which were welded to the lower round portion of the hinge. In this way a perfectly serviceable door, which swings easily and accurately, was quickly made.

Then, again, the firm had some old fly-presses which it wished to use for rather heavier work than that for which they were originally designed. It was found quite easy to weld together a sort of frame-work from odds and ends of channel and angle iron, which perfectly satisfactorily gave the additional strength required—see Fig. 4. The result was not, perhaps, æsthetically beautiful, but it did what was wanted, and it did it cheaply. When the strengthened machine was got to work, it was found that the additional duty which it was called upon to perform set up undesirable racking in the table on which it stood—a table, be it said, that had itself previously been built up of steel angles by welding. That trouble was got over by the judicious application of struts made of steel angles. No particular pains were taken to fit them accurately. If handy scrap pieces were short or not quite square at the ends, the spaces left between their ends and the frame of the machine were filled in by welding, that method being very much cheaper than would have been the work of fitting and screwing in position. Again, the result—see Fig. 4—was not handsome; it could hardly be expected to be, but it proved to be perfectly efficaciou and it was very quickly and cheaply arrived at.

There are places in the shops where the floors are not precisely at the same level, since various buildings have been added from time to time, and the difference in level was found to make it troublesome to wheel heavily weighted trolleys from one place to another. The method employed to surmount the difficulty was to fasten a strip of fairly thick sheet on the flat along the edge of the higher level, and to weld to it another piece of thick sheet or a plate set at an angle downwards, so as to meet the lower level floor. It was quite simple and quick to carry out, but it has answered its purpose perfectly, having in the examples we have seen lasted for years, notwithstanding some fairly rough treatment.

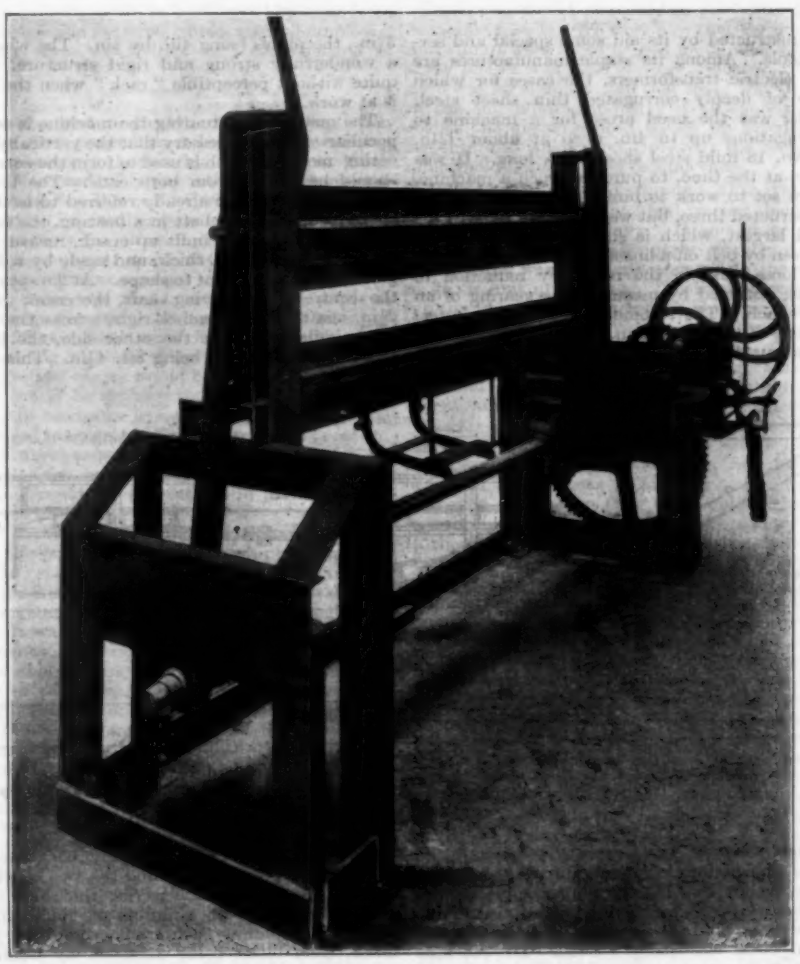

FIG. 6—CORRUGATING MACHINE BUILT UP BY ARC WELDING

We are far from having exhausted the list of "od-

jobs," if we may so call them, which have been carried out at these works by arc welding, but we have said enough to show what sorts of things have been done. The points on which we desire to lay particular stress are that in all the cases we have enumerated (*a*) the work has been quickly and cheaply done, and (*b*) that materials to hand have been nearly universally employed. In a large number of cases they have simply been taken off the scrap heap. Not the least important point is the speed with which the work has been carried out. Wants have apparently been filled almost as soon as they have been experienced.

The firm has, however, by no means confined itself to "odd jobs." It has, as we shall now proceed to show, carried the use of electric arc welding far enough

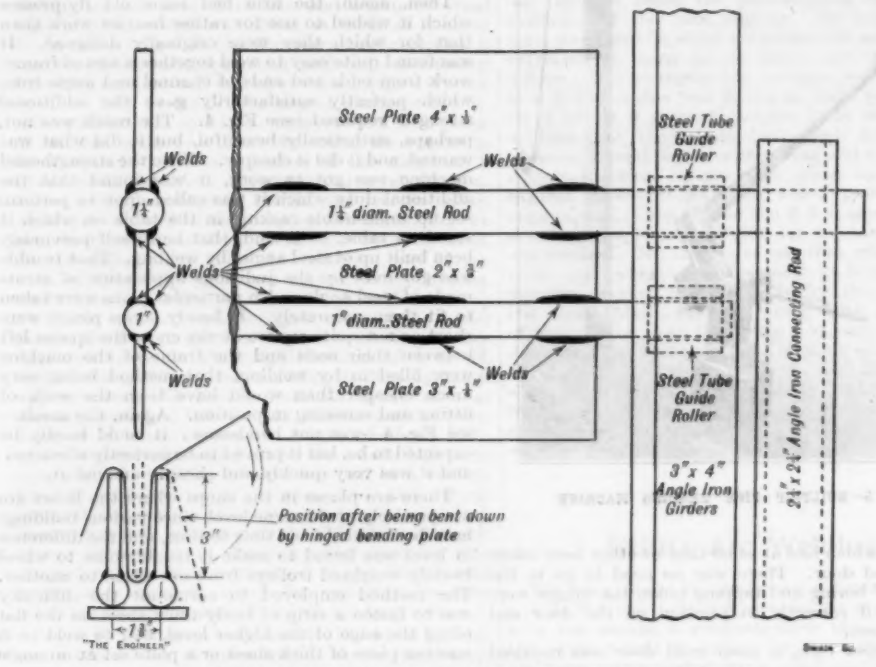

FIG. 7—DIAGRAM OF ONE END OF CORRUGATION-FORMING MEMBER

facing the other, and each having the 3in. faces arranged parallel to one another at a distance apart of 2in. At the bottom these angles are welded to the 10in. channel, and the two members of each pair are bolted together at the top with a 2in. distance piece between them, the bolts used being the two referred to above. This arrangement forms two guides, 2in. wide, exactly facing one another, the distance apart of the two pairs of uprights being 6ft. 9½in. In these guides there reciprocates vertically the member which forms the corrugations, and which we shall describe in detail later. The two end frames are built up entirely of angles, channels and plates, every joint being arc welded. The angles employed are 3in. by 4in., and the channels 2in. by 4in. and 2½in. by

to have constructed by its aid some special and serviceable tools. Among its staple manufactures are oil-cooled electric transformers, the cases for which are made of deeply corrugated thin sheet steel. During the war the need arose for a machine to form corrugations up to 4in. deep at about 1½in. pitch in No. 18 mild steel sheets, 6ft. long. It was impossible, at the time, to purchase such a machine, so the firm set to work to build some for itself. In all, it constructed three, but we need only refer to the latest and largest, which is shown in Fig. 6. It is power-driven by belt off a line shaft, and is fitted with fast and loose pulleys, the necessary reduction in speed being obtained by means of the gearing of an old crab winch. That, some pieces of 2½in. steel shafting, one of them 8ft. 4½in. long, and four or five 2½in. plummer blocks, were, we believe, the only

5½in., the plates being 4in. by ½in. The whole forms a wonderfully strong and rigid structure, which is quite without perceptible "rack" when the machine is at work.

The method of actuating the machine is somewhat peculiar. It was necessary that the vertically reciprocating member which is used to form the corrugations should be driven from both ends. The final drive from the winch gear already referred to is through a short piece of 2½in. shaft in a bearing, the far end of the shaft carrying a built up crank, measuring 3½in. on the face and 2½in. thick, and made by welding together steel strips bent to shape. At 9in. centre from the centre of the driving shaft, the crank receives a 2½in. shaft, which reaches right across the machine to a similar crank at the other side, the length of shaft between cranks being 8ft. 4½in. This shaft, in

width of the guide. It will be gathered that as the main shaft with its long crank pin revolves, the reciprocating member, as we have called it, is raised and lowered through a height of 18in. for each revolution.

The reciprocating member, which is about 6ft. 8in. long, is built up in the following manner:—At the top there is a length of 4in. by ½in. steel plate arranged with its width vertical. It rests on a 1¼in. steel rod, and is welded to it at ten places in the length of the plate, the welds being from 2½in. to 3in. in length, and being made on both sides of the plate. It is these rods which are extended to pass through holes in the actuating connecting-rod. Beneath the horizontal rod is a piece of ⅜in. plate, 2in. wide. It, too, is welded to the rod above it and also to another rod, in this case, 1in. in diameter, which is arranged immediately below it. The ends of this 1in. rod are extended sufficiently to reach between, but not to project beyond, the upright end guides, and each end is furnished with a piece of steel tube to act as a roller working in the guides. Finally, at the bottom there is a further strip of ¼in. plate, 3in. wide. The general construction is shown diagrammatically in the sketch—Fig. 7—which represents one end of the reciprocating member, with its guide rollers, the upright angle iron guide and the connecting-rod. The corrugations are formed by the reciprocating member descending into a "mould," which is formed by two pieces of steel plate welded to two steel bars, 1in. in diameter, spaced at 1⅜in. centres, and welded parallel to one another on a piece of steel plate, the underside of which is furnished with pins, which fit into holes in the 10in. channel forming the table of the machine. By this arrangement, it is possible to change the mould for different depths of corrugation. One half of a corrugation is formed at each descent of the corrugator blade. When the latter is in its lowest position, the uncorrugated portion of the sheet projects upwards, something as shown by the full line in the left-hand bottom corner of the sketch—Fig. 7. To bend it downwards into the position indicated by the dotted lines, a bending plate, which is hinged at many points to the front of the middle plate of the reciprocating member—see Fig. 6—is brought into play. It is furnished with two lever arms made of stout pipe, and by pulling the latter forward and downward the bending plate is revolved, pressing the sheet being dealt with downwards and completing the corrugation.

The corrugated plate, after each corrugation is formed, is lifted from the "mould," if we may so call it, by the long crank pin in its revolution coming into contact with a swinging frame, which is hinged to the centre of the table of the machine, and which impinges on a cross bar carrying two pins which project vertically upwards through the table, and come between the two bars forming the bottom of the mould. The sheet when removed from the mould is turned upside down and end for end, and a further corrugation made.

We have gone somewhat in detail into the construction of this machine because we consider that the interest of the subject warrants it. We have not been informed as to the total number of hours that were needed to build it, but the total sum paid out for labour was only £14, while the material cost, at the prices ruling when the machine was made, £22. The total expenditure was therefore only £36, and at to-day's prices it would be considerably less than that. We may say that for the purpose of making

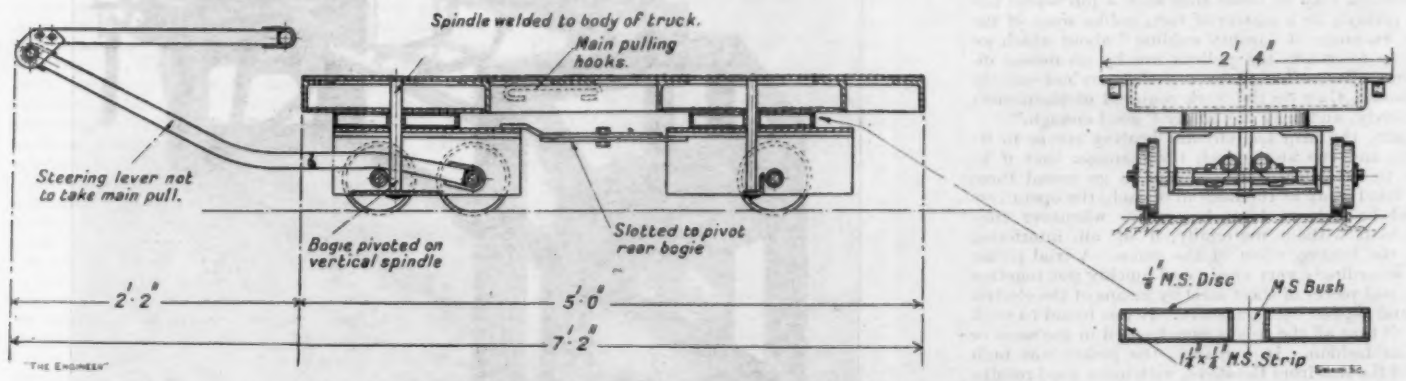

FIG. 8—SIX-WHEELED, DOUBLE-BOGIE TROLLEY, BUILT UP BY ARC WELDING

special parts which it was necessary to procure, all the rest of the material was actually taken out of stock. Saving for securing the plummer blocks and for one other purpose which will be mentioned in due course, there is not a bolt used anywhere, every single joint being electrically welded. The machine consists of a frame at each end, built up of steel angles and channels, connected together at the top by a 10in. by 4in. steel channel, 7ft. 6in. long, arranged with the channel downwards, so as to leave a flat table, and welded to the top faces of the end frames; the bottoms are also connected at the floor level by means of a piece of 4in. by ½in. steel plate. Mounted vertically on the 10in. channel, one at each end of it, are two pairs of 3in. by 4in. angles, each pair exactly

spite of its length, may actually be considered as being only a crank pin joining the two cheeks of the cranks. As the machine works, the shaft describes a complete circle at a radius of 9in. Embracing the shaft, adjoining each crank, there is a plummer block, each block being attached by welding to a connecting-rod of box cross section, which is formed by welding together two lengths of 2½in. angle iron. These connecting-rods, which are 3ft. 10½in. long, are pierced with holes at their farther ends to receive round steel rods, which project from the ends of the reciprocating member. These round rods, where they pass between the upright guides, are furnished with steel rollers, made of short lengths of steel tube, which are just a shade less in diameter than the

the welded portions show up more clearly in the photograph from which our engraving was reproduced, they were gone over with chalk. They consequently seem to be considerably more prominent than they actually are. The same remark applies equally to the other photographs which are reproduced.

We will refer to just one other special tool. It is the pipe bender shown in Fig. 5. With the exception of the grooved rolls, of which there are three, the clamping blocks and one or two bolts, the machine is entirely built up of odds and ends—channels for the most part—though the top and bottom edges of the bending arm are formed of flattened 1in. steel tubes welded to junction pieces of steel plate. The

lever is formed of a stout steel pipe reinforced at the bottom on each side by a taper piece of V-shaped sheet steel, all welded together. To give further stiffness, there is a piece of bar steel at the lower end of the pipe inside it. The ingenious method of operating the machine will be noted. A pulley on the line shafting is made to do the work, sufficient tension only being put on the rope to enable the pulley to get a grip on it. The machine, as shown, is actually as it stands in the shop, but, for clearness sake, the background and part of the line shafting have been painted out. The machine cost £1 10s. for labour and £1 5s. for material. It is perfectly effective, and has done a lot of work, many bent pipes for circulating the cooling oil in transformer cases being used by the firm in its manufactures.

Finally, we may draw attention to the trolley which is illustrated in Fig. 8. It is made up principally of steel plates, angles and pipes, and its construction will be readily understood. The truck has to run on narrow gauge lines, as well as on the floor of the shops. The wheels are of cast iron, and the flanges are each formed by two thicknesses of strip steel, bent into ring form in hand rolls, the inner being welded to the cast iron of the wheels and the outer welded to the inner ring. We may say in passing that arc welding was much used in the laying of the narrow-gauge lines, which are formed of steel angles, as may be seen in the drawing. The trolley, which has for a long while now been in constant use, and is frequently made to carry loads up to 6 tons in weight, cost £4 for labour and £5 for material.

We have even now not come to the end of the list of things which we have had the pleasure of examining at the Foster Company's works. But this article has already reached an inordinate length, and we can afford no more space. We would only add that the work to which we have alluded has all been performed by means of arc welding with alternating current of 50 periodicity, the initial voltage of 220 being stepped down by transformer.

In conclusion, we would tender our best thanks to the Foster Engineering Company and to its Transformer Department manager—Mr. R. I. Bagnall—for the facilities afforded to us for visiting the works and for the help in preparing this article which was extended to us.

Institution of Naval Architects.

No. I.

THE annual meeting of the Institution of Nava Architects opened in the hall of the Royal United Service Institution on April 5th under the presidency of the Duke of Northumberland. There was an excellent attendance. The report of the Council was presented.

REPORT OF THE COUNCIL.

In submitting the annual report for the past year the Council expresses pleasure in noting a further steady increase in the membership of the Institution.

The financial statement appended to the report shows a satisfactory balance of income over expenditure, and the Council believes that the rate of subscription, which, in the case of many similar societies had to be increased, is adequate for the present needs of this Institution.

In view of certain cases of straitened circumstances among members of the Institution that have been brought to its attention, the Council expresses a desire to see established a Benevolent Fund for necessitous cases of this kind, supported by voluntary contributions on lines similar to those of certain other Institutions, and a resolution authorising the Council to contribute out of the funds of the Institution a sum not exceeding £100 per annum to this Benevolent Fund was submitted to the members.

Joint Committee on Marine Oil Engine Trials.—A Committee for investigating the results of certain forthcoming trials with oil-engined ships has been formed jointly with the Institution of Mechanical Engineers, and is composed as follows:—*Institution of Naval Architects:* Engineer-Vice-Admiral Sir George Goodwin, K.C.B., Mr. Ruck-Keene (Lloyd's Register), Mr. T. Carlton (Board of Trade), Mr. James Barr (British Corporation), Mr. George Anderson (Bureau Veritas), Engineer-Commander C. J. Hawkes, R.N. (Ret.), and Mr. G. S. Baker. *Institution of Mechanical Engineers:* Mr. W. H. Patchell, Captain H. Riall Sankey, Mr. L. A. Legros, Mr. L. Pendred, Mr. W. Reavell, Mr. R. Williamson. Engineer Rear-Admiral R. B. Dixon, C.B., will represent the Admiralty on this Committee. Richardsons, Westgarth and Co., Limited, have promised to place at the disposal of the Committee a Diesel-engined ship, fitted with Beardmore-Tosi engines, which is expected to be ready for trials during the course of this summer. It is hoped that other firms will offer similar facilities, in order to broaden the basis upon which the investigation will be carried out.

Conference of Engineering Institutions.—At the invitation of the Institution of Civil Engineers, a joint conference, consisting of representatives of four Institutions—Civil Engineers, Mechanical Engineers, Naval Architects, and Electrical Engineers—at which Sir John Biles and Sir W. E. Smith attended on behalf of this Institution, was recently held to consider whether, and if so, in what respects, closer co-operation between engineering societies is desirable. This matter is still under consideration.

British Marine Engineering Design and Construction Committee.—The work of the Committee with regard to water-tube boilers is now completed, and the proposed rules have been agreed to and will be submitted to the Board of Trade and registration societies for their consideration.

Scholarships.—Two additional scholarships, to be given by the firm with whose names they are associated, viz., Naval Architecture, "Armstrong Scholarship," £150 per annum for three years, and Marine Engineering, "John Brown Scholarship," £150 per annum for three years, have been accepted.

The Institution Premium for 1921 has been awarded to Mr. W. R. G. Whiting for his paper on "The Strength of Submarine Vessels."

The Secretary announced the names of officers elected and re-elected for the current year as follows:—President, Duke of Northumberland; Vice-presidents, Lord Pirrie, Sir William Smith, Sir Archibald Denny, Engineer-Vice-Admiral Sir Henry Oram, Sir Charles Parsons, Sir Alexander Gracie, Mr. S. W. Barnaby, Mr. R. Saxton White, Mr. J. Foster King, Sir Thomas Bell, Engineer-Vice-Admiral Sir George Goodwin, Mr. Andrew Laing, Sir Eustace Tennyson d'Eyncourt, Mr. W. H. White, Mr. James Bain, and Mr. A. E. Seaton. Sir Charles Parsons was appointed honorary treasurer. Members of Council elected were Mr. W. J. Bell, Mr. John Gravell, Sir George Hunter, Mr. Summers Hunter, Mr. A. W. Johns, Mr. A. W. Luke, Mr. H. Ruck Keene, Mr. H. C. Williams, and Mr. Harold Yarrow; associate members of Council, Professor W. E. Dalby, Sir Alexander Richardson, and Sir Charles Sanders.

The President, in a brief inaugural address, congratulated the Institution on the increase in membership and on the satisfactory financial situation revealed in the report. Reference was made, he said, in the report to the formation of a committee to conduct marine oil engine trials as the outcome of an offer made by Messrs. Richardsons, Westgarth and Co., to place at the disposal of the committee for test purposes a Diesel-engine ship. He would point out, however, that the trials could not be carried out to the extent desired to give complete results unless other firms were also prepared to lend vessels, and he took that opportunity of making an appeal on behalf of the committee. Great satisfaction would, he thought, be felt at the invitation extended by M. Bertin and the members of the Association Technique Maritime to members of their Institution to participate in a summer meeting in Paris in July, where the Institution had not met for a period of twenty-seven years. The Council hoped that the gathering in Paris would not only yield important results on the scientific side, but lead the way to improved relations between the two countries. This country was now faced with serious trouble in the engineering and shipbuilding industries. With the matters in dispute the Institution was not concerned, but the members were affected by the consequences of that dispute. The latest news was happily somewhat more favourable, and suggested that the stoppage of work would not involve some of the other unions associated with the Amalgamated Engineering Union. Unfortunately, the stoppage had come at a time of unprecedented depression in trade. He could only express the hope that labour would realise that the interests of all engaged in industry could be best served by some form of joint association between employers and employed for looking after the welfare of those engaged in industry.

The reading and discussion of papers was then begun, the first paper taken being the interesting and important contribution by Sir Westcott Abell entitled "Merchant Shipping and World Commerce in Relation to Sea Power," of which we reprint the greater portion on another page.

It can scarcely be claimed that the debate was worthy of the subject, which the author has treated from a somewhat new aspect.

Sir John Biles said that he regarded the paper as of supreme importance. It contained a mass of valuable statistics and some interesting reflections on the meaning of those statistics. The usefulness of the figures and charts would be generally admitted, but there would be differences of opinion as to the deductions to be drawn from them. The war period had interfered to so great an extent with the ordinary process of development that it was impossible to reach conclusions based on statistics covering that period which could be of great aid in predicting the future course of events.

Mr. W. H. Whiting pointed out that the author suggested the present depression in shipbuilding was not due to the depression in trade, but to the excessive production of 1920 and 1921. It was true there was an enormous rise in production during those years, but it was only equal in quantity to the previous deficiency, and it could not therefore, he thought, be claimed that the increase in production was the sole cause of the existing unprecedented depression in the shipbuilding industry. It seemed more probable that the decline was due rather to the collapse in trade and the general financial unstability throughout the world. The author defined sea power as a combination of healthy commerce and the mercantile marine and the Navy. These were not separate things. Commerce was dependent on shipping and land transport. Nor, as was shown by the case of the United States, was a healthy commercial condition dependent on the possession of colonies. There were certain to be differences of opinion as to the meaning of sea power which was so admirably defined by Captain Mahan, but the author of the paper was to be congratulated on having tackled a difficult task with great courage.

Admiral Sir E. Fremantle agreed that in the minds of sailors the Navy always included the mercantile marine. During the Great War fresh proof was given that the fighting ship was dependent on the merchant ship. In the case of Great Britain, one of the causes of the sea power possessed was the sea instinct of the people, and he did not think the author had laid enough stress on the importance of the human element. There was also the geographical characteristics of Great Britain to be taken into account—no part of the country being at any great distance from the sea. A fighting navy, as the history of France had shown, could not be maintained on any large scale without a strong mercantile marine, and this consideration applied to some degree at least to the United States to-day. In that country geographical factors must also be taken into account, as they made it difficult to induce the people to adopt a seafaring occupation.

Sir Charles Sanders reminded the meeting that from a date early in the year 1915 it was his duty to discuss week by week with Sir Westcott Abell the question of merchant shipbuilding, and its relation to the ultimate victory of the Allies. It had been said that the merchant ship was always regarded as part of the fighting machine, but that was not so in 1914 or at the beginning of 1915. It was only the searchlight of the war which enabled the Allies to realise that the men and ships of the mercantile marine were an integral part of the forces of the Empire, and equally important in a long struggle as the ships of the Royal Navy. Most of those engaged in sea affairs recognised this, but it was not until unrestricted submarine attack on merchant shipping was resorted to by the enemy that the nation as a whole recognised the value to the nation of the shipbuilding, engineering and ship-owning industries. Sir Westcott Abell had done good service in showing a lead in this scientific study of shipping interests. Sir John Biles had investigated a part of the same subject in his search for the economic ship. We needed more and more the aid of science in our industries. Rule-of-thumb methods must be abandoned, and the author's introduction to the scientific investigation of sea interests was of vital importance to all of them. Too little influence had, he thought, been attached to physical and geographical features. We could, under normal conditions, build cheaper and better ships than other people. The world position to-day was, of course, to a great extent abnormal, but if the statistics and the interpretation which should be placed upon them could be accepted, it was certain the outlook for shipbuilding was very bad indeed. There were, however, special conditions which should be taken into account. It was true that a large amount of tonnage was laid up, but at least 50 per cent. of it ought to be scrapped. If the cost of shipbuilding could be reduced, it would, having regard to the fact that a large percentage of the shipping afloat was in need of replacement, invite the adventure of shipowners who would place orders for better and more economic vessels. We were told that periods of boom and slump were more or less inevitable. Neither of these phases was good for any industry. The great need was for stability, and that could only be achieved in the shipbuilding industry if all concerned would realise the absolute need to set up a federation of sea interests which would prevent the recurrence of abnormal fluctuations in capital value.

Mr. Archibald Hurd thought that the author, perhaps unintentionally, had rather belittled the value of the Royal Navy. It should be borne in mind, however, that the early merchant ships of the country were not only engaged in the transport of goods, but in fighting. The warship was evolved for the protection of merchant shipping, and it was to be noted that the Washington Treaty expressly reserved the right to arm merchantmen. The nations might, indeed, be driven to arm all merchant ships, and that would have a considerable influence on design and the details of ship construction. Sir Westcott Abell had made no reference to air power, but if a bombing aeroplane could sink a battleship, what would be the position of a merchant vessel in face of that menace? Nothing had, however, yet happened to suggest that we should be compelled to carry our commerce by air instead of by sea. In the Great War aircraft had not been able to stop our maritime communications. To-day, however, it was necessary to design warships to meet the attack of aircraft as well as submarines. From the economic standpoint, the maintenance of our sea power unimpaired was a prime necessity. We had to import our food, and whereas wheat could be carried by sea from New York to Liverpool for .5d. per lb., land transport from Liverpool to London cost more. Rice could be brought from Rangoon to London at a cost of 1.47d. per lb., and the rate from London to Liverpool was nearly as much. These figures, and they could be multiplied, would give an idea of the value of sea power to Great Britain. With regard to shipbuilding, it had been suggested that wages in the home industry should be stabilised for one year, with the object of bringing about a revival. That would not help our considerable export trade in ships, nor compel the British shipowner to order new ships from home yards. This aspect of the situation was sometimes overlooked.

Mr. J. C. Joughin referred to the danger that, in consequence of the reduction of the *personnel* of the Navy, the surveying service might be cut down to a dangerously low limit. It seemed to him that the time had arrived when merchant shipping and allied interests should take charge of surveying work.

Sir Norman Hill, in a written communication, dissented from the definition of sea power given by the author. Ship-carrying power was, he insisted, a thing to be sold like coal. Its possession conferred power, but at the most the power of production. Any

country possessing the vehicles of sea transport must bring them into the market. A nation which attempted to use sea-carrying power to concentrate the commerce passing through its ports in its own ships would bring disaster to that commerce by depriving it of the advantage of the freight market.

Sir Westcott Abell, in a brief reply to the discussion—with which he will deal fully in writing—disclaimed any idea of depreciating the value of the Navy. In his treatise on "Sea Power," Mahan had been mainly concerned with the fighting ship, and that was perhaps the reason why he (Sir Westcott) had concentrated on the merchant ship. He recognised the importance of the character of a people and geographical features in connection with sea power, but had not gone into the details of these questions. On the subject of air power, it would seem that it had not yet reached the stage of development which would make it necessary to change the method of transport by sea. The main object of his paper was to carry the consideration of sea power a step further than had been done by Captain Mahan.

On the motion of the President, a hearty vote of thanks was accorded to the author for a paper which it was generally agreed had opened up a new avenue of investigation.

The annual dinner of the Institution took place on the evening of April 5th at the Connaught Rooms. The Duke of Northumberland presided, and the guests included Lord Lee (First Lord of the Admiralty), Signor de Martino (the Italian Ambassador), Sir Joseph Cook (High Commissioner for Australia), Mr. Baldwin (President of the Board of Trade), Mr. P. C. Larkin (High Commissioner for Canada), Sir Edgar Walton (High Commissioner for South Africa), Sir Philip Watts (Vice-president), Mr. Amery, and Mr. H. A. L. Fisher.

Lord Lee, replying to the toast of the "Royal Navy," said it was a very alarming and even sobering thought that now, according to some gentlemen, it was only necessary to drop a bomb somewhere near a battleship—the distance varied according to the cost, anything from a near miss to a splash in the offing—for the battleship to proceed to sink. He had answered that claim at some length in Parliament. The battleship still remained the ultimate basis of sea power, and he had perfect confidence in the profession of those assembled that night to be able to adjust designs to cope with the new dangers and maintain the battleship in its present position. Nothing would make them believe that the menace of the air was really serious or vital as against battleships. He deplored the exploitation of those crude theories in the lay Press, because they were bound to unsettle the mind of the man in the street and to shake his confidence in that great Service, which, after all, was now and was going to be always the sure shield of the Empire. On his return from Washington he was amazed to find that there was in full blast a campaign of depreciation of the value of the Navy to the Empire and a vilification of all those who were concerned with naval policy. He was greatly concerned that the Board of Admiralty, and particularly its naval members, should have been attacked in a way which to him was as unaccountable as it was unjust, because he did not believe there ever had been a Board of Admiralty upon which there had been so many sailors distinguished by their brilliancy, not only as leaders in the war, but by their mental capacity, and it was a grotesque libel to suggest that they could still think only in terms of war. He had never served with a body of men, in or out of politics, who had taken a more broad-minded, statesmanlike view with regard to the necessities of the time, or had a keener appreciation of the financial straits in which the country stood and the corresponding need for economy.

Low Temperature Carbonisation.*

Much attention is at present being directed to the carbonisation of coal at low temperatures with the primary object of producing a solid smokeless fuel which shall take the place of coal for domestic purposes. The idea was first definitely brought forward by Mr. Parker in 1906 of the distillation of coal at a temperature of from 400 deg. to 450 deg. Cent. in contradistinction to the gas-making and coke-oven practice of using temperatures ranging from 900 deg. to 1300 deg. Cent. At temperatures below 600 deg. or 700 deg. Cent. the oil and gas products differ materially from those which are obtained by high temperature processes. The primary products of distillation, consisting of the saturated and allied hydrocarbons, are preserved, instead of being cracked up, owing to their contact with high-temperature bodies. A small quantity of rich gas is produced, together with a quantity of oil. The solid residue, which contains about 10 per cent. of volatile matter, forms an excellent smokeless fuel. If the whole of the coal at present used for domestic purposes were subjected to carbonisation at low temperature the advantages derived would include the conservation of the valuable oil products, thus rendering this country self-supporting to some extent in the matter of fuel oil supplies. The general use of smokeless solid fuel would to a great extent solve the problem of the production of a clear atmosphere in our large towns, although it would not of necessity obviate the damage due to dust and sulphur given off by the products of combustion.

It is here necessary to lay stress upon the wide difference between the solution, on the one hand, of some local problem of carbonising at low temperatures materials which are of the nature of waste products, commanding only a low price on the market, and, on the other hand, the design and production of an apparatus which would solve the national problem by showing a profit when working on a material such as domestic coal. The latter is infinitely more difficult of solution than the former, since the raw material of the process forms the principal competitor of the finished product, and the margin for working is necessarily small. In other words, if, by starting with a slack costing from 10s. to 15s. per ton, a material can be produced which will command a price of 35s. to 40s. per ton, an apparatus can be used which would have no chance whatever if it were necessary to start with lump coal at a price little if at all short of that commanded by the resultant low-temperature fuel. As an illustration of this, I may refer to a well-known system of low-temperature carbonisation which has met with considerable success in the United States of America. In the district where this process is being developed, the smoke laws render it impossible to find a market for bituminous coals, and anthracite commanding high prices is invariably used for domestic purposes. Some figures in my possession give the price of bituminous coal as 3 to 4 dols. per ton, and of anthracite as 9 to 12 dols. In this connection several plants are in existence showing a profit which would vanish were any attempt made to use the system in the solution of our national problem. It may be said with confidence, however, that considerable progress has been made towards this end; and, in view of the large number of firms and individual investigators engaged upon the question, its elucidation may quite well be within measurable distance.

The files of the Patent Office testify to the numerous ways in which inventors have approached the subject of low temperature carbonisation; but it will be found that most of the ideas there presented will group themselves into a limited number of classes. One broad classification might be taken as to whether the heat is applied externally to some type of fire-clay or metal retort, as in the gas or shale oil industry, or whether an attempt is made to carry heat directly to the material under carbonisation by means of hot gases, vapours or liquids. Let us now glance briefly at one or two typical apparatus and methods.

The Fuel Research Board has always recognised the necessity for obtaining reliable fundamental data on the methods of treatment of various types of coal, the yields of product obtained, and the heat expended in the process. For the past two and a-half years, therefore, the Research Board has been working with a bench of horizontal steel retorts, charged and discharged by hand labour. The size of each retort is such as to allow two shallow trays of broken coal to be inserted and left for the period of carbonisation. The retorts are heated by water gas, which is allowed to burn quietly in a large combustion chamber completely encircling the retorts, except in front, where charging and discharging take place. The low-temperature gases are taken out by pipes at the rear end of each retort, and are then passed through a complete condensing and exhausting system. The coal is first broken down roughly by the use of a disintegrator with one set of bars running. It was found at an early stage in the experiments that the apparatus did not lend itself to the production of a satisfactory coke from the more highly fusible coals. Experiments using mixtures of dry and fusible coals in almost equal proportions have, however, been completely successful in the production of a satisfactory low-temperature fuel.

The practice at H.M. Fuel Research Station is to withdraw the charge after the giving off of an amount of gas corresponding to 3000 cubic feet per ton, since little is to be gained by continuing the carbonisation process beyond the stage of 3000 cubic feet per ton.

At the Fuel Research Station a method of assay has been worked out from which it is possible to deduce with considerable accuracy the products to be expected upon the large scale from carbonisation of any material. The apparatus consists of a miniature retort of silica, which can be heated under perfect control. A sample of 25 grammes of coal ground to pass a 60 mesh is used, and the liquid and gaseous products are accurately measured. From the laboratory apparatus the quality of the resultant coke can also be judged. Typical yields from suitable mixtures of coal carbonised at H.M. Fuel Research Station are:—Coke, 14 cwt. per ton; oils, 15 gallons per ton; gas, 3000 cubic feet per ton; liquor, 24 gallons per ton; ammonium sulphate, 6 lb. per ton.

No trouble whatever has been experienced with the working of these retorts. After having been under heat for two years, they are now in just as good condition as when they were first installed. The labour cost per ton is high, however, and the ground space large per unit of output. It follows, therefore, that, although this type of retort might possibly prove a commercial success in countries where a large margin exists between the cost of the raw material and that of the finished product, and where land and labour are cheap, it would certainly never prove a paying unit in Great Britain.

Carbocoal Process.—This system has met with some considerable degree of success in America. It involves the subjection of the material to a preliminary low-temperature carbonisation at 480 deg. Cent. in carborundum retorts of an inverted heart-shaped section. The coal is first crushed and fed to these retorts, through which it is urged by rotating helical paddles. The preliminary carbonisation occupies some two to three hours. After passing through the retorts, the material—which is mainly in the form of breeze—is briquetted with pitch, and then subjected to a second process of high-temperature carbonisation at from 1000 deg. to 1100 deg. Cent. in a kind of coke oven. The solid product thus obtained contains 3 per cent. of volatile matter, and is an excellent smokeless fuel, robust and standing transport well. Low-temperature oils of paraffinoid type are produced in the preliminary carbonisation, together with a small quantity of rich gas. High-temperature tar, containing aromatic compounds, &c., and a quantity of lower-grade gas, are obtained in the second carbonisation. The plant at Irvington is capable of producing 100 tons of fuel per day, but has now been exclusively devoted to research work. A larger plant of 600 tons daily capacity at Clinchfield is successfully at work. The main disadvantage of the process is the double heating, which is necessarily expensive, but the plant appears to be a thoroughly practical proposition in cases where a wide margin exists between the raw material and the finished product.

Barnsley Retorts.—These retorts have been described so fully in the Press during the last few months that it is unnecessary for me to deal with them in great detail.† Briefly, however, they are vertical fire-clay retorts of elongated section. Each is fitted with plates so arranged as to collapse when carbonisation is completed. The charge is dropped with ease, and previous troubles have been overcome which were caused through sticking in retorts. This successful discharging is also partly due to the fact that the Barnsley Company is now using a mixture of fusible and dry coals, thus avoiding the familiar difficulty associated with the passing of the material through a pasty condition.

Del Monte System.—This system was experimented with before and during the war, using for the purpose what is known as the Chiswick retort. A long helical screw conveyor is contained within a tube, which is heated externally by gas. Suitable scrapers are provided in order to prevent the material being carried round by the rotation of the worm; and gas offtakes are so disposed as to remove the gas as soon as possible after its evolution. This retort possesses the advantage of keeping the coal thoroughly stirred during carbonisation, thus facilitating the entry of heat to the mass.

Systems Utilising Internally Applied Heat.

Several systems are in course of development which depend for their heat supply upon the passing through the material or hot gases. Of these three typical examples are:—

(1) *Maclaurin Retort.*—The Maclaurin retort consists of a vertical producer of large diameter. Steam and air are blown in, as in ordinary producer practice, and the mixture of N_2, CO_2, and H_2O evolved from the lower zones is allowed to pass through a large mass of coal in the upper portion of the retort. The material is carbonised by the sensible heat of these gases. It has, however, to run the gauntlet of the high-temperature zone at the lower end. Here a small portion is gasified by the action of air and steam, but the greater proportion passes through the hot zone, and is withdrawn at the bottom of the retort. This apparatus is cheap, and can deal most effectively with large coal of double nut size and upwards. The fuel produced makes an excellent fire, and can be graded into foundry coke, domestic coke, smithy char and breeze. The retort can be so run as to produce at will either a metallurgical coke or a domestic fuel. An interesting plant has been erected at Grangemouth, and the process is attracting considerable attention in Scotland.

(2) *Neilsen Retort.*—In this system carbonisation is carried out by the sensible heat of gases generated in a separate producer. In a small plant which has been erected for experimental purposes at Chatterley, the retort consists of a rotating cylinder 36ft. long by 3ft. internal diameter. A Dowson producer supplies gas at a temperature of 800 deg. Cent., and this passes over the coal, so parting with its heat. On reaching the exit pipe the temperature of the gas has fallen to about 250 deg. Cent. The coal in the form of slack passes through the retort in about three to four hours, and is finally discharged at the high-temperature end, after having been subjected to cooling in a separate chamber, which envelops the retort. Very fusible coals can be used in this retort, contrary to possible expectation. This is attributed by the inventor to the dust contained in the producer gas which is deposited upon the particles of coal, thus preventing sticking, on the same principle as the dusting with flour of her pasteboard by the housewife.

In all forms of internally heated retort, success depends upon keeping the losses low, since the heat is supplied by low-grade gases heated to fairly definite temperatures. Any heat loss has to be made up by an increase in the volume of the low-grade gas supplied; and since the latter is mixed with the rich low-temperature gas, an excessive supply can only result in the deterioration of the final gas product. With care, however, it is possible to produce gas of about 250 B.Th.U. per foot, and which has therefore a fair commercial value. The chief disadvantage attending the use of internally applied heat is the large volume of resulting gas and the consequent increase in the expense of condensing and stripping.

(3) *Sutcliffe Speakman Process.*—In this process the coal is first dried and ground, after which it is compressed, cold, into briquettes. Mixtures of coal and coke, or of two different kinds of coal, are usually employed. There is, therefore, no expansion in carbonising, which is effected in retorts heated internally, by circulating gas alternately over the briquettes in the retort and a regenerator heated independently.

At a meeting held in the Caxton Hall, S.W.1, last month, an interesting lecture on "Power Factor Improvement" was delivered by Mr. G. H. Ayres, who first dealt with the nature of the power factor of an alternating current circuit, and showed how a low power factor necessitated additional plant to deal with a given load as well as requiring cables of larger section. The lecturer then described in fairly full detail methods of improving low power factor, dealing first with static condensers. Several types made by the British Insulated and Helsby Cables, Limited, were illustrated. The Scherbius phase advancer and the Miles-Walker correcting apparatus were then described. The oscillator or vibrator designed by Dr. Gisbert Kapp was also dealt with, and various forms of this, made by a number of electrical firms, were shown on the screen. Comparative costs per kilowatt-ampère of the several methods were given. The lecturer also made mention of the ways in which electricity supply authorities encouraged good power factor and penalised low power factor, stating that the most practical method seemed to be to fix a "datum" line for charges, and deduct from or add to this in the same proportion as the consumer's power factor rose above or fell below the selected percentage.

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* From a lecture delivered before the Institution of Mechanical Engineers, South Wales Branch, by Dr. C. H. Lander, Assistant to the Director of Fuel Research.

† The Engineer, October 28th, 1921.

A Seven-Day Journal.

Proposed Empire Airship Company.

JUST in time to anticipate the handing over of our remaining airships to the Disposals Board a scheme, backed by Vickers Limited and the Shell oil group, has been submitted to the Government for the formation of a company to operate a commercial airship service between Britain and India, with an ultimate extension to Australia. The proposed company is to have a capital of £4,000,000, of which £3,400,000 are to be secured forthwith by the issue of shares. Towards this sum each of the supporting companies has undertaken to subscribe £100,000. The Government's part in the scheme is to consist of the handing over to the company free of cost all existing airships, material and bases, to supply wireless telegraphy and meteorological services, and to guarantee the interest on the capital for a period of years. In the last-named connection the estimated annual subsidy required until the company became self-supporting would be £91,000 from Great Britain, £40,000 from Australia, and £40,000 from India. The existing airships would be used for training purposes and for short trips, new vessels of 3,800,000 cubic feet capacity being built as the scheme developed. The undertaking would be begun with a bi-weekly service to India followed, when experience had been gained, with an alternate day service to India extended once a week to Australia. Bombay, it is estimated, would be reached in 5½ days, and Perth, West Australia, in 11½.

Home Grown Sugar.

IT is an open secret that while the efforts made to establish the sugar beet industry in this country have met with a very considerable amount of technical success, the position on the financial side was such as to cause much concern to those interested in the business. The announcement made in Parliament by the Minister of Agriculture to the effect that the Government has decided not to levy any excise duty on home-grown sugar has therefore been received with much pleasure. It is intended to provide for the removal of the existing duty in the forthcoming Finance Bill, but while the remission cannot be made effective until that Bill has been passed by Parliament, the announcement made by Sir Arthur Boscawen should in itself be sufficient to enable growers to plant their beet this year with an assurance that it will not be left on their hands. The object of the Government is, of course, to assist the industry during its experimental period. It follows, therefore, that the remission of the duty is not necessarily to be perpetuated indefinitely.

The Shoreham Mystery Tower.

FULL official information regarding the purpose for which the two so-called mystery towers were built during the war is not yet available, but a little fresh light has been thrown on the subject in an answer given in Parliament by the Financial Secretary to the Admiralty. The towers, it would seem, were originally built "as part of a scheme of defence which was not completed when the war ended." The unfinished scheme, it was added, cost about £1,266,000. It will be recalled that one of the towers in September, 1920, was towed out of Shoreham harbour, where it and its fellow were built, and was made fast or sunk on to the sea bottom close to the Nab lightship at the entrance to Spithead. It was equipped with lights and a signal bell, and became known as the Nab Tower. The other tower is still in Shoreham harbour, and for a long time past has been a source of much trouble to the harbour authorities. The Admiralty has now decided that the most economical course is to demolish it. It stands about 180ft. out of the water, and is composed of some 12,000 tons of reinforced concrete.

Trackless Trolley Tramcars in London.

IN the course of the second reading of the London County Council (Tramways, Trolley Vehicles and Improvements) Bill, under which the Council seeks power to equip a route in the south-eastern suburbs on the trackless trolley system, strong opposition to the proposal was submitted on behalf of the Borough Councils concerned in the matter. Under the Londno County Tramways Act of 1900, the Borough Councils have the right to veto the introduction of any overhead system of traction. After considerable discussion, it was decided that an instruction moved by Lieut.-Colonel Assheton-Pownall and seconded by Sir Philip Dawson should be inserted in the Bill to the effect that the provision of the earlier Bill as to local veto should be observed. This instruction was carried by a majority of eighty-six votes to seventy-two. In the course of the debate one speaker described the proposal as the dying kick of the tramway system, another said that if carried out the scheme would be the source of endless trouble, while a third maintained that the omnibus company was able and willing to supply all that was wanted. Among those in favour of the scheme, one member stated that the trackless trolley system would cost £20,000 as compared with £200,000 for the conduit system, and that in York the trackless tramway was being worked 6d. per car-mile cheaper than the omnibuses. A Labour member argued that the Bill was necessary in the interests of cheap travel, and added that in the fourteen towns and cities in this country in which the trackless trolley system was in operation, the results were abundantly successful.

Resignation of Sir Frederick Sykes.

ON the expiration of his original three-year term of office, Major-General Sir Frederick Sykes, on the first of the month, resigned his appointment as Controller-General of Civil Aviation at the Air Ministry. Although invited to continue his duties for another year, he ultimately came to the conclusion that the very small scale to which it has been found necessary to reduce the Department of Civil Aviation left no scope for such a position as his, and that he would not be justified in continuing "even for a year to receive a salary for work which circumstances made it impossible for him to perform." His resignation has been accepted, but there is every possibility that his services will be utilised in a voluntary capacity in connection with the duties of his former post.

Croydon Flying Festival.

THE promotion of a great flying festival at the London Air Station, Croydon, is now being discussed in conference between the Air Ministry, Aircraft Constructors, Aero Club, Aeronautical Society, and Air League. The festival is to last a week, will probably take place early in 1923, and is being designed to fasten attention on flying in a way that has hitherto not been found possible. The main feature of the festival will be an exhibition of every type of modern flying machine, including, it is hoped, helicopters. Concurrently, an international congress on air problems will be held and speed and duration tests organised and decided. An effort is also being made to arrange that the Royal Air Force annual pageant shall be held at Croydon during the week.

Coal Strike in the United States.

ON the first of the month over half a million coal miners in the United States went on strike in resistance to the demands of the owners for wage reductions. With 6000 coal mines idle and the possibility of some 200,000 railway men and other workers throwing in their lot with the miners, the country seems to be confronted with one of the greatest labour struggles in its history. It is estimated that with each day of the stoppage the miners will lose £600,000 in wages, while the loss of output will amount to 1,200,000 tons of bituminous coal and 300,000 tons of anthracite. The reserves of coal in the country are stated to be sufficient for about two months' supply. The strike is expected by some to last from six to eight weeks in the anthracite districts, and from three to six months in the bituminous fields. The progress of the conflict will be watched with close interest in this country, for it is bound to react on the British coal exporting industry.

Re-organisation of Yarrow and Company.

ON account of his advanced age—he is now over eighty—Sir Alfred Yarrow has decided to give up his position as chairman of Yarrow and Co., Limited. The firm was founded in 1866, and before its removal from Poplar to Scotstoun was turned into a limited liability company on a private basis. It is now going into voluntary liquidation with Mr. Harold Yarrow as liquidator. A new company—Yarrow and Co. (1922), Limited—is being formed, with Mr. Harold Yarrow as chairman and Mr. Marriner and Mr. Crush as directors. Although Sir Alfred is giving up the duties of chairman, he will continue his interest in the firm's welfare, and will give the new company the benefit of his advice and guidance. Since the end of last year the Scotstoun yard has been temporarily closed down except for some experimental and research work. The technical and other staffs have, however, been retained so that operations may be resumed as soon as favourable conditions arise.

The Microphone.

WE were interested to hear from Mr. A. A. Campbell Swinton, who occupied the chair at the dinner of the *Dynamicables* on Tuesday last, the romantic history of the collection of apparatus which Hughes employed forty years since when inventing the microphone. Some time ago the authorities of the British Museum asked Mr. Swinton if he would be good enough to report on the value of twenty manuscript notebooks by Hughes which had come into their possession. He consented, and on examining the books found references to apparatus. Impelled to make further inquiries, he learnt that a quantity of "miscellaneous rubbish" belonging to Hughes was to be found in a furniture repository off the Tottenham Court-road, where it had lain since Hughes' death. He found two rooms packed with all sorts of "household and personal effects," and amongst them were ultimately discovered the microphone apparatus which is now exhibited at the Science Museum. The most interesting thing about Hughes' work was his anticipation of wireless telegraphy. He employed a clock to make and break circuit, and armed with a battery, a microphone, and a telephone he walked down the street listening. It is recorded that he picked up messages at a distance of three hundred yards. That was in 1879! It is satisfactory to know that a connected account of Hughes' life and work is likely to be prepared from the material now available.

The Engineering and Shipbuilding Disputes.

THE outstanding feature of the week in connection with the engineering dispute is undoubtedly the fact that on Tuesday evening the three federations of unions, other than the Amalgamated Engineering Union, announced their willingness to accept the employers' revised memorandum as the basis of negotiations, provided the employers would suspend the operation of the lock-out notices against their members under which work was to terminate on the following day. The employers agreed to this course, and immediately took steps to suspend the notices until May 1st. Negotiations between the employers and the unions are to begin on Monday, and, if necessary, are to continue for the whole of the week. Thereafter a fortnight will be allowed for the purpose of taking a ballot. The revised memorandum to which reference has been made was issued on the first of the month, and prescribed the acceptance of the principle that, "pending negotiations," the management had the right "to give instructions except where modified by agreement which may be entered into as a result of the negotiations which follow hereon." The memorandum also specified that the employers and the negotiating Committee of the unions would endeavour to adjust mutually their ideas as to the manner in which the principle of management and the functions of trade unions would be applied to the circumstances of the cases to be discussed. The negotiating Committee regarded this memorandum as representing a sufficient change in the employers' attitude as expressed in the memorandum of November, 1921, to warrant its entering into direct discussion with the employers. Meanwhile, the Amalgamated Union remains outside the negotiations and the lock-out of its members continues. In the shipyard wages dispute the ballot of the men resulted in a vote of 26,451 in favour of accepting the employers' proposed reduction of wages, and of 87,026 against, showing an adverse majority of 60,575. The strike therefore continues.

Naval Vessels Under Construction.

ACCORDING to information given in the course of Parliamentary business, there are thirty-two vessels at present under construction for the Navy, representing a total cost, including guns, of about £20,500,000. The vessels are all cruisers or smaller craft, the exact details being seven light cruisers, six destroyers, eight submarines, six coastal motor boats, one minelayer, two flotilla leaders, and two aircraft carriers. Many of the vessels have been under construction since 1917. It was added on the same occasion that since the Armistice no subsidies had been paid to any armament firm.

Sir Edward Capel Cure.

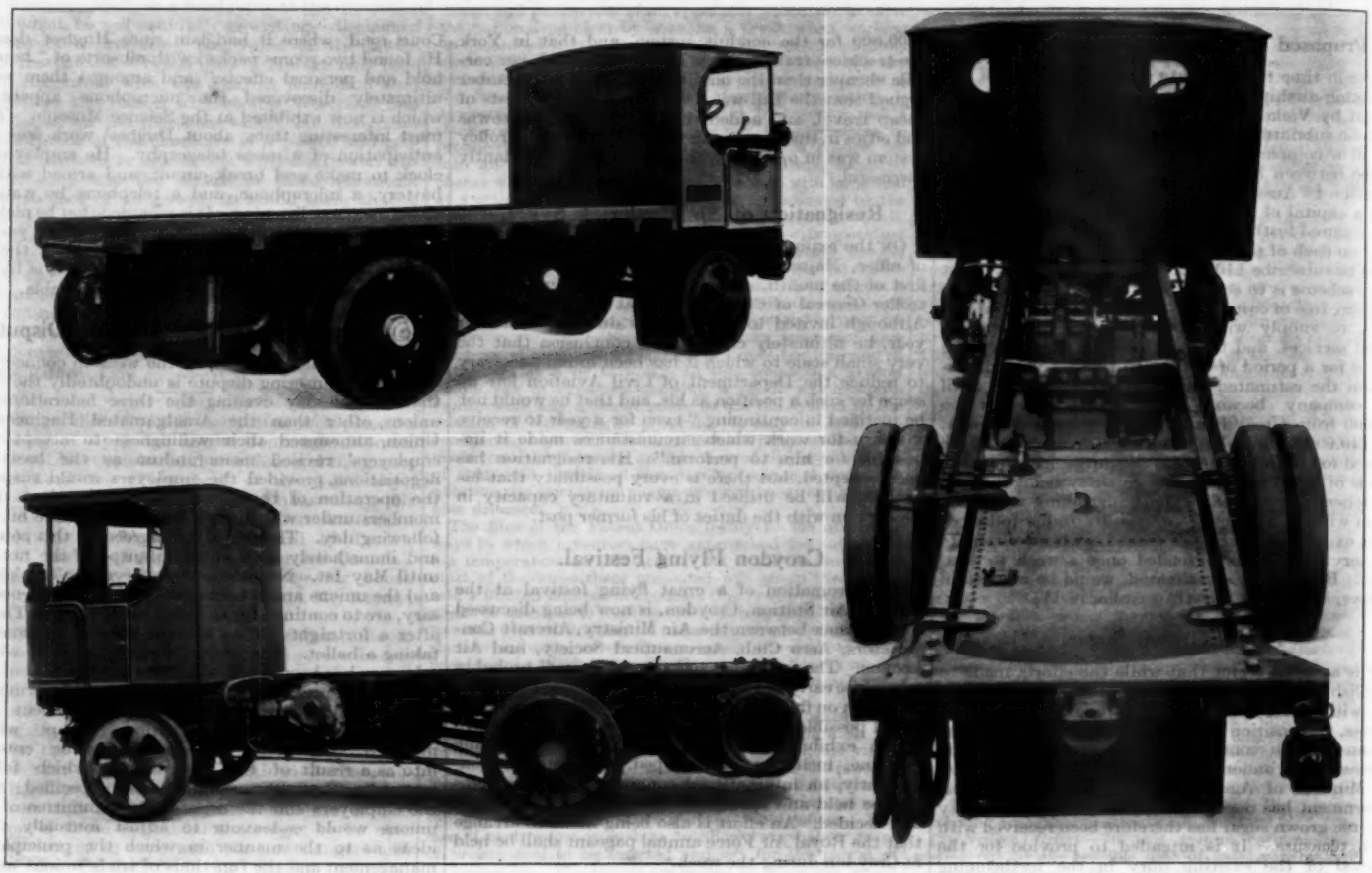
WE may share the general regret that is felt in Italy at the retirement from the British Embassy at Rome of Sir Edward Capel Cure. Sir Edward held for a number of years the very important post of Commercial Attaché, and, full as he is of affection both for his native country and for the country in which he has spent so many years of his life, he did much to maintain the friendly feelings between the two nations. During the war he took part in many inter-allied conferences on financial matters, and won by his tact and courtesy the respect of all parties concerned. We may add that before entering the British Embassy many articles from his pen on Italian industries and industrial questions appeared in our columns. We join heartily with his friends in Italy in wishing him every happiness in the retirement he has so well earned.

Fast Trip by the Mauretania.

ON her first voyage since being converted for the burning of oil fuel the Mauretania made what is said to be the fastest passage across the Atlantic by any liner since the war. She arrived at New York last Friday at 6.30 a.m., 5 days 12 hours 17 min. after leaving Southampton. The route followed was the longer southern one of 3161 miles, so that her average speed was 23.93 knots. During the last portion of the trip the mean speed over 183 miles rose to 25.31 knots. In her early days the Mauretania established the Atlantic speed record at 26.06 knots.

SIX-TON UNDER-TYPE STEAM WAGON

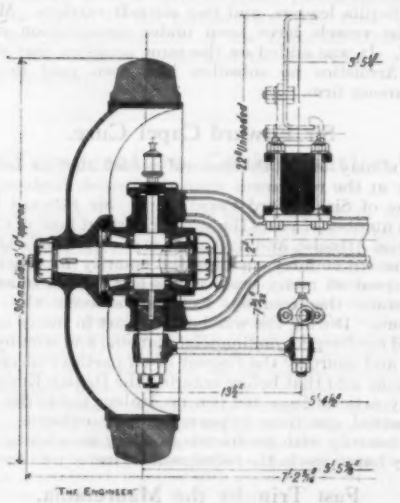
RICHARD GARRETT AND SONS, LIMITED, LEISTON, ENGINEERS



Garrett Under-Type Steam Wagon.

THE wagon which forms the subject of this article, and which is illustrated by several drawings and reproductions of photographs, has been recently completed by Richard Garrett and Sons, Limited, of Leiston, in Suffolk. It is an interesting vehicle, because a particularly good standard of workmanship and design for this class of products has been aimed at, and because the makers set out to produce a lorry that would have a high average speed, make its way along the worst of country roads, and surmount all reasonable hills with its maximum load of 10 tons.

One of the first features that will strike those who examine the drawing which forms our Supplement to-day is the employment of a pressed steel frame. It gives the great advantage that depth can be provided just where it is needed, and that the straining, and even breaking, which occasionally happens with built-up frames can be wholly prevented. Care has been taken to reduce as far as possible the number of bolt holes through the pressings, and we believe we are right in saying that there is not a single hole through either of the flanges, save at the extreme ends. Three of the views given show the frame very clearly.



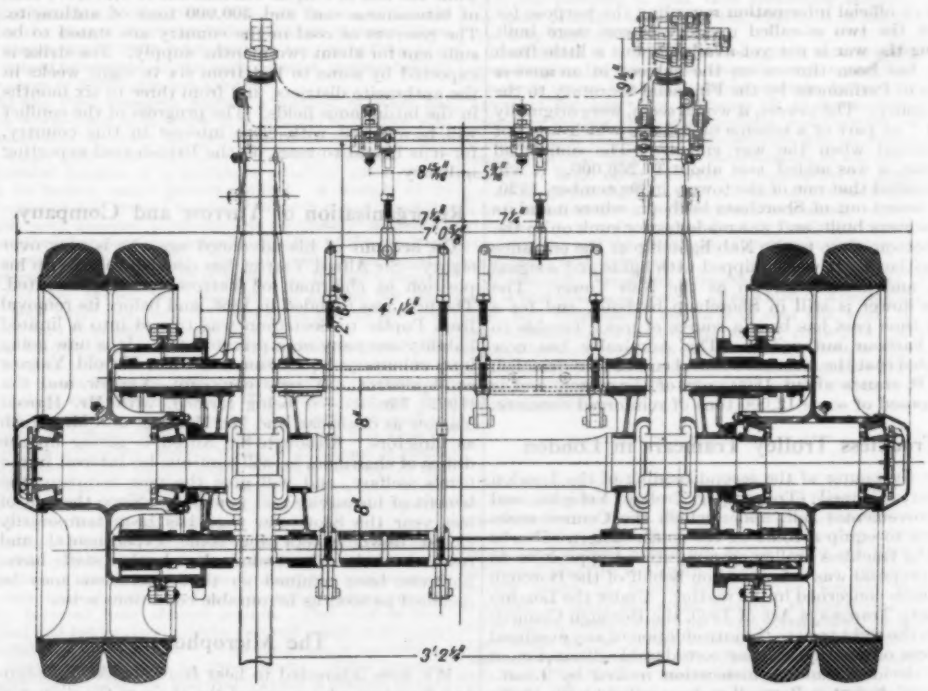


FIG. 1—FRONT WHEEL, BACK AXLE AND BRAKE GEAR

The next feature that strikes the eye is the double chain drive. It permits the employment of a dead back axle and the use of a small machine-cut differential on the countershaft. The makers are convinced, too, that it is the best for soft roads and bad weather conditions.

Another feature which is not readily visible in the drawings is the pedal speed regulator. As a matter of fact, the speed is controlled by an accelerator, just as it is in a motor car. The pedal operates a carefully designed double-beat valve in the steam pipe and so regulates by throttling. Further control is given by the expansion gear operated by a lever on the driver's right. Another feature which can only be gathered from the general arrangement is the provision of a two-speed gear operated by a lever on the left of the driver's seat. Finally, we have the fact that Timkin roller bearings are employed throughout.

After this general survey we may look at the principal parts in more detail.

With the boiler we need not deal, as it is not to be retained in future wagons. It is of the well-known

"Sentinel" type, designed for a working pressure of 250 lb., and is fired from the top. Richard Garrett and Sons have got out the designs for a boiler fired through a shoot near the bottom and having all the tubes pointing fore and aft. A door in the front of the boiler will give access to these tubes and enable them to be cleaned as required.

The engine is shown clearly in Fig. 2 below. It has two high-pressure cylinders, 4¼in. diameter, with a stroke of 7½in. The double stuffing-box will be noticed. It prevents steam or water by any chance finding its way to the enclosed crank chamber. Access to the big-ends, &c., is gained through light doors shown on the drawing, and easily accessible

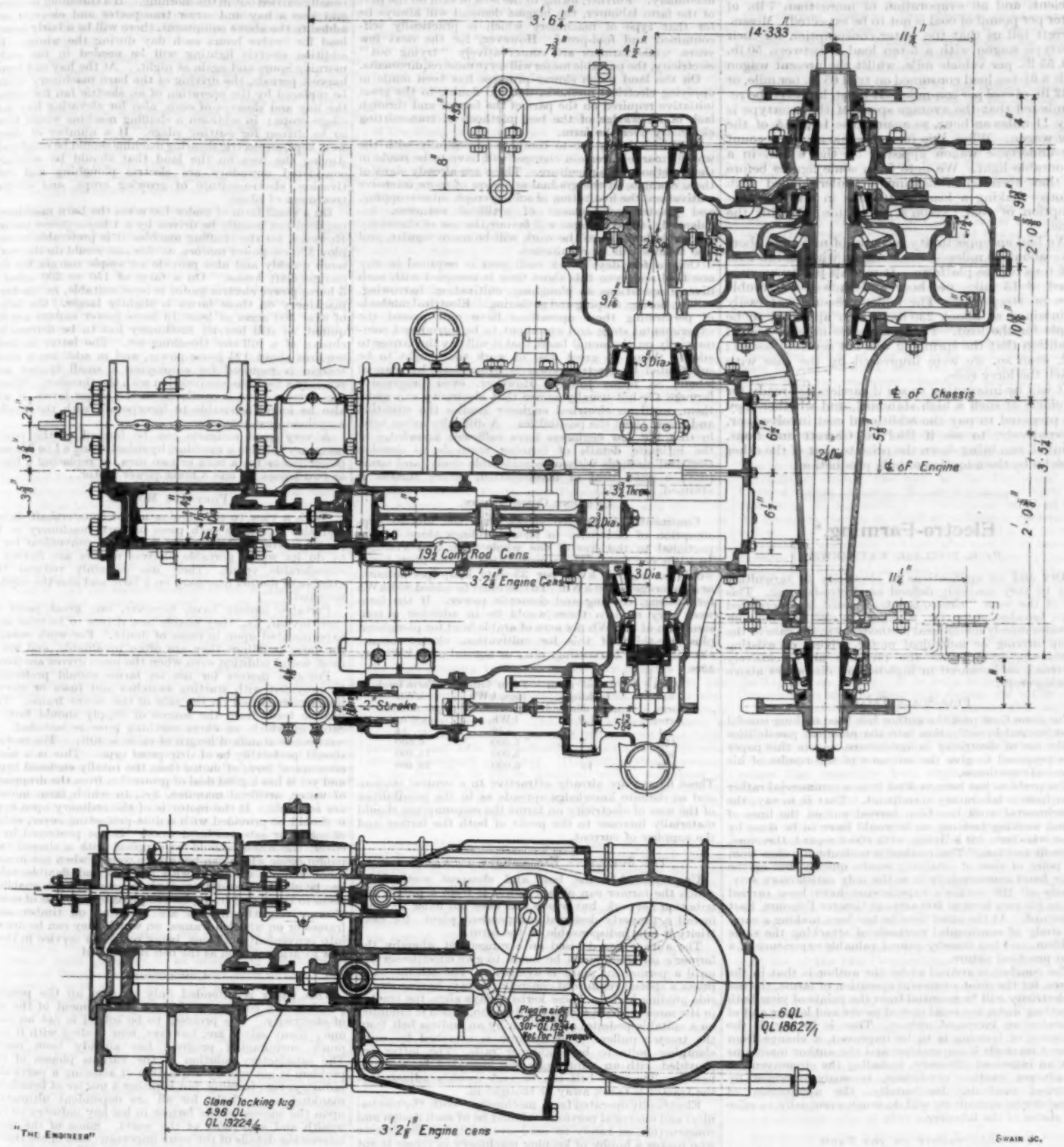


FIG. 2—SECTIONS THROUGH ENGINE AND COUNTERSHAFT CASING

through the floor of the wagon. The valves are of the piston type operated by Joy gear. With this gear better distribution is given by outside than by inside admission, and the latter is therefore used. Three through bolts, two below and one above, hold the engine up to the countershaft casing, whilst an eye on the upper bolt supports the forward end from a transom in the frame. The crank shaft is prolonged in both directions. On the near end it carries a pinion which operates the feed pump, and on the off end a pair of sliding pinions is mounted. These pinions, with the corresponding wheels on the differential, constitute the change-speed gear. The engine is stopped on those rare occasions when it is necessary to use the high ratio pair. The differential presents no features of special interest, but the method of carrying the countershaft casing should be carefully observed. At each end a spherical bearing is provided in the bracket, but whilst at the off end the bearing is fixed to the casing, at the near end the casing is free to slide endways. By this arrangement any strains which might otherwise be transmitted from the frame to the casing are avoided. The grouping of the Timkin roller bearings also deserves to be noticed. It will be seen that support is afforded as close as possible to the point of pressure. Felt rings are inserted wherever necessary to exclude dust. The eyelets for the radius rods are seen in this figure. The radius rods themselves are steeple-shaped, as well shown in the sectional plan through the rear axle, Fig. 1. The axle itself, as already noted, is dead, the wheels revolving on it on roller bearings. This drawing shows also the brakes and their gear.

The brakes themselves, seen best in Fig. 6, p. 388, are of the internal expanding type. Each shoe is in two parts, hinged together at one end and held together by a spring at the other. Expansion is effected by a square on the end of the brake shaft. The inner pair of brakes is operated by a foot lever and the other pair by a hand lever. A suitable compensating gear, as shown in the sectional plan, is provided. It will be noticed that the chain sprocket is formed in one with the brake drum, and that the complete ring is readily removable from the wheel centre, which, we may here mention, is of cast steel.

A drawing of the front wheels and axle is also shown in Fig. 1 and speaks for itself. Steering is effected by a worm and worm wheel seen in Fig. 7 and Fig. 8. In the latter view, taken from the fireman's side of the cab, the feed-water heater and the mechanical lubricator are prominent objects.

The form of the tank is best seen in the illustrations, page 384, of the complete lorry, in which the method of carrying it in the frames is well shown. Besides the feed pump, Fig. 4, an injector is also provided. The feed pump and the injector draw from the sump in the tank through separate orifices. The pump—Fig. 4—being in continuous action, circulates the feed from the tank and back to it again. In the piping a valve, operated by one of the levers seen on the steering column, is fitted, and by throttling the circuit causes as much of the water as may be necessary to pass through the feed heater and thence through a pipe which enters the steam space. The injector—under the driver's seat—draws cold water and delivers it through the check valve on the front and right of the boiler into the water space. The feed heater is of the tubular pattern, and Messrs. Garrett have satisfied themselves that it is really effective.

It will be seen from this brief description, and more

particularly from the drawings, that Richard Garrett and Sons have produced an exceptionally interesting wagon. Whether a machine with so many refinements can be sold at modern competitive prices is for the makers to decide. They believe that by adopting modified mass production methods they will be able to sell these vehicles at no greater extra cost than the purchaser will be ready to pay for the quality offered and for such a detail as the two-speed gear, the necessity for which not infrequently arises in country districts.

We do not think the makers claim for it exceptional economy in fuel, and it is probable that in that respect their own overtype lorry with a locomotive boiler would beat it. No one yet has succeeded in making a very small vertical boiler that is highly efficient, and an evaporation of more than 7 lb. of water per pound of coal is not to be expected. Messrs. Garrett tell us that the water consumption for their overtype wagon with a 5-ton load is between 50 lb. and 55 lb. per vehicle mile, whilst the present wagon with a 6½-ton load consumed on trial 65 lb. per mile, or 1.32 lb. of coal per ton-mile. It must, however, be remembered that the average speed of the overtype is only 11 miles an hour, as against the 14 to 15 of the new wagon. When this factor is taken into account the undertype wagon appears, on the whole, in a favourable light. We note from some figures before us that even when hauling a trailer loaded with 4 tons—making a load of 10 tons in all—the consumption of coal (Nixon's navigation) remains the same.

We had an opportunity recently of making a short run—about 10 miles—in this wagon with its full load of 6 tons on the platform. It made a pretty average speed of 15 miles per hour and showed no trouble even on steep hills. The boiler pressure was easily maintained at about 230 lb., which appeared to be ample for the load. The roads were in such a good condition that the springing was not severely tested; but, even so, we were impressed by the ease with which the lorry rode.

It will be interesting to see if carriers are ready for a vehicle of such a high standard, and whether they are prepared to pay the additional cost involved, or, alternatively, to see if Richard Garrett and Sons, Limited, can bring down the price to that of the other vehicles by the adoption of bulk production.

Electro-Farming.*

By R. BORLASE MATTHEWS.

Any and all applications of electricity to agriculture may be very concisely defined as electro-farming. This use of the term "electro-farming" must be interpreted in its broadest sense, *i.e.*, whether the electrical medium provides merely mechanical methods, as in the case of the group driving or individual motor driving of existing machinery, or whether the methods are exclusively electrical, as instanced in high-tension discharges above growing crops.

Full-Scale Trials.

For some time past the author has been making careful experimental investigation into the practical possibilities of the use of electricity in agriculture, and in this paper it is proposed to give the outcome of the results of his practical experience.

The problem has been tackled from a commercial rather than from a laboratory standpoint. That is to say, the experimental work has been carried out on the lines of actual working farming, as it would have to be done by those who farm for a living, with strict regard, therefore, to profit and loss. This method is undoubtedly slow from the point of view of obtaining results quickly, but on the other hand commercially it is the only satisfactory way. Nearly all the author's experiments have been carried out on his own farm of 600 acres at Greater Felcourt, East Grinstead. At the same time he has been making a careful study of continental methods of attacking the same problem, and has thereby gained valuable experience of a most practical nature.

The conclusion arrived at by the author is that in the future, for the most successful operation of farms, the use of electricity will be essential from the points of view both of cutting down the total cost of power and labour and of obtaining an increased output. That is to say, if the efficiency of farming is to be improved, a change from present methods is imperative, and the author maintains that an increased efficiency, including the circumvention of adverse weather conditions, is easily obtained by electrical methods. Incidentally, the application of electricity to agriculture will do much eventually to raise the status of the labourer.

Electricity on the Farm.

The question as to what extent it is advantageous to apply electricity on any farm depends naturally on the size of that farm. For farms of under 150 acres careful thought must be given to ensure that an adequate return is obtained for the capital expended, as the number of hours of use of each machine is limited. Similar care must of course be taken in designing installations for larger farms, but, as the hours of use are longer, it is not so easy to make a mistake in regard to the equipment. On every farm the uses of electricity may be roughly classified under the following headings:—

(1) Uses in the farm buildings.
(2) Uses on the farm land.
(3) Uses in connection with the treatment of gathered crops.
(4) Uses in the farm house.

* Abstract of paper read before the Institution of Electrical Engineers on March 30th, 1922.

A table given in the paper* shows the very wide scope which exists for electricity on a modern farm and it is believed that this table will be found of considerable assistance when considering the possibilities of the applications of electricity on any particular farm.

General Observations.

Many of the applications of electricity to farming are closely allied to procedure in other industries, as they are after all dependent only upon broad general principles. In general, most of the problems associated with electrical drives inside the farm buildings are now solved—except that, as in other industries, many radical changes will have to take place in the design of the actual machines. Incidentally, as so many farm buildings are ill-adapted for the mounting of countershafts and the like, there will obviously be an increased demand for self-contained machinery. Further, owing to the lack of skill on the part of the farm labourer, the biggest demand will always be for that type of machinery which is practically self-contained and fool-proof. However, for the next few years, while farmers are conservatively "trying out" electricity, the portable motor will serve most requirements.

On the land much slower progress has been made in applying electrical methods, due, no doubt, to the great initiative required on the part of the farmer and through lack of knowledge of the best methods of transmitting electricity over the farm.

If British farms are to compete successfully with the world's markets, certain changes will have to be made in their methods of agriculture. There are already signs of those changes, in the gradual adoption of more intensive cultivation, the institution of soiling crops, inter-cropping, and greater employment of artificial manures. Incidentally, these changes will favour the use of electricity on arable land, since the work will be more regular, and idle fallows will be eliminated.

Only a few days' work each year is required in any one field and even this short time is occupied with such diverse operations as ploughing, cultivating, harrowing, rolling, hoeing, reaping and gathering. Electrical methods of performing these operations have now passed the experimental stage and are about to be introduced commercially on the sound basis that it will pay the farmer to adopt them. A great deal of work that ought to be substituted by electric power is being done by manual labour on farms to-day. However, even progressive farmers are not usually aware that electricity can assist them, until an electrical engineer studies the situation and shows them the possibilities. A difficulty arises here, in that but few engineers have sufficient knowledge of the intimate details of farming methods to develop electrical methods without considerable study, and sometimes a good deal of investigation, before success is attained.

Current Consumption.

Continental experience shows that the annual consumption of electricity in farm buildings alone is proportional to the size of the whole farm and averages 10 kWh per acre. The consumption in the farm house would average 7 kWh per 33-watt lamp per annum, or an average of 210 kWh. To this must be added 800 kWh for heating, cooking and domestic power. If the farm were very modern there would be in addition a consumption of 33 kWh per acre of arable land for ploughing, plus one-third of this for cultivation, electro-culture, electric silage, harvesting, etc., or a total of 44 kWh per acre.

Area of farm. Acres.	Usual farm buildings, max. demand. H.P.	Farm buildings, kWh per annum. kWh.	Farm land, kWh per annum. kWh.
1	—	10	44
150	3	1,500	6,600
300	5	3,000	13,200
600	15	6,000	26,400

These figures are already attractive to a central station, and as definite knowledge spreads as to the possibilities of the uses of electricity on farms the consumption should materially increase to the profit of both the farmer and the supplier of current.

The Supply of Electricity to Farms.

Unquestionably the best and cheapest method by which the farmer can obtain power is from a public distribution network, but where this does not exist he must install a properly designed independent plant—for electricity is now indispensable on the farm.

The author has devised an arrangement whereby the farmer's oil tractor can be made to give effective service until a permanent plant is available. The scheme comprises a special reinforced concrete runway, having strong side guiding kerbs. These kerbs always align the tractor in the same position facing the dynamo, which is mounted on a suitable pedestal and driven by an endless belt from the tractor pulley. The dynamo is attached by cam-clamping bolts to belt-tightener rails. The latter are provided with an adjusting screw operated by a crank handle. Thus the belt can be very quickly adjusted as the tractor is taken away or brought in.

Electrically operated farm machinery—both the mechanical and electrical portions—should be of such design and construction as rarely to need overhaul, for the farmer who makes a hobby of keeping machinery in repair is apt to neglect his crops and stock. This, in fact, is one reason why machinery is not employed to a greater extent on some farms. A trouble that is often encountered with farm electric motors is damage by moisture, due either to rain or to condensation. It is difficult to avoid this, unless to design the motors so as to be as waterproof as is feasible. Ball-bearing electric motors are to be preferred for farm use, if provided with good felt packings, as frequent lubrication is eliminated. Undoubtedly, the most practical motor for farm use is the three-phase squirrel-cage type. For farms of over 300 acres the author favours three-phase power installations on this account, coupled with the fact that, as soon as a public power supply is available, it is nearly certain to be three-phase supply, and so the farmer who already has a private installation will not have to change his motors.

On a farm where other than manual power is employed in the barns, the machines most commonly in use are hay chaffers, root cutters and pulpers, grinding mills, cattle-cake breakers and firewood saw benches. These machines are chiefly used during the winter time, and even then for only a few hours daily. Hence, at first thought, the load factor of a farm does not appear to be very attractive. However, if electricity is available, experience shows that it will soon be employed for a variety of other purposes, if only the attention of the farmer is drawn to its possibilities. A very important use, where water is not already laid on, is for driving the water pump for general farm purposes and also for domestic use. Still another service which may be reckoned among the essentials is the driving of a liquid-manure pump. If a dairy herd of more than ten cows is kept, it is advisable to employ a motor-driven cream separator and also a milking machine. For the driving of the milking machine 2 to 3 horse-power is required. The preparation of food for the live stock is usually carried out in the morning. If a threshing machine and also a hay and straw transporter and elevator are added to the above equipment, there will be a fairly heavy load for twelve hours each day during the winter. In addition electric lighting will be needed in the early morning hours and again at night. At the hay and corn-harvest periods, the driving of the barn machinery would be replaced by the operation of an electric fan for curing the hay and sheaves of corn, also for elevating hay and silage crops; in addition a chaffing machine would have to be driven for cutting silage. If a number of sheep were kept, an electric shearing machine should be employed. Among the uses on the land that should be seriously considered nowadays are electric ploughing and cultivation, electro-culture of growing crops, and electric treatment of silage.

On a small farm of under 150 acres the barn machinery required can usually be driven by a 1 horse-power motor. However, for the chaffing machine it is preferable to employ 3 horse-power motors, as this size would do the work more quickly and also provide an ample margin for the countershaft losses. On a farm of 150 to 300 acres a 5 horse-power electric motor is most suitable, as the barn machinery on these farms is slightly larger. On farms of over 300 acres at least 15 horse-power motors are required, as still heavier machinery has to be driven, inclusive of a full-size threshing set. The latter in itself requires about 12½ horse-power, and in addition a small margin is required for employing a small trusser and possibly a feeder in conjunction with the thresher. Where the electric drive is available on the larger farms, it will also be found advisable to incorporate with the chaffer a cyclone dust-extractor.

A very good estimate can be formed of the power necessary to drive a machine, by substituting a ½ to 2 horse-power motor for a man or two men, or replacing a horse or two horses by one 5 horse-power motor.

Portable Motors.

With a view to the elimination of countershaft drives and also to enable each piece of barn machinery to be placed in the position where it is most convenient for it to do its work, portable electric motors are having a considerable vogue. Their use certainly reduces the number of motors necessary on a farm and also the capital invested.

Portable motors have, however, one great point in their favour, *i.e.*, they enable new drives to be tried and experimented upon in cases of doubt. For work outside the farm buildings they are often invaluable, and are a most useful addition even when the main drives are fixed.

Portable motors for use on farms should preferably be provided with starting switches and fuses or circuit breakers mounted on the side of the motor frame. The flexible leads from the source of supply should form a cable in which an extra earthing wire is included. A convenient standard length of cable is 40ft. The motors should preferably be of drip-proof type. This is a more economical form of motor than the totally enclosed type, and yet it has a good deal of protection from the droppings of water, artificial manures, &c., to which farm motors are so liable. If the motor is of the ordinary open type it should be provided with a dust-protecting cover, either of metal or asbestos-lined wood. If not protected by a cover, the motor should be supplied with a shaped tarpaulin cover which can be thrown over it when not in use. Small motors complete with starters and flexible cable can be obtained ready mounted on handled bars, enabling them to be carried from place to place by a couple of men; alternatively the motors are mounted on timber skid frames or on wheeled frames, on which they can be drawn into convenient positions, being ready for service in their new location as soon as the belt is attached.

Conclusion.

This paper is intended only to sum up the present position of a comparatively new development of the use of electricity. The problem to be solved is not an easy one; many minds are, however, now dealing with it and much encouraging progress has already been made. The satisfactory solution of the various phases of the problem is not merely a question of assisting a particular industry, viz., farming, but is rather a matter of benefiting mankind as a whole for all are dependent ultimately upon the success of the farmer in his key industry to the wealth and well-being of the world. Some of the more interesting details of the more important uses of electricity applied to agriculture—among them electro-culture—are given in an appendix* to the paper. This appendix, coupled with the paper, will indicate that scientific electro-farming is one of the chief factors in furthering the world's progress.

* Not reproduced.—Ed. The E.

The number of men employed on the Midland Railway before the war was roughly 73,000 and the total salaries and wages bill amounted to £5,690,000. In January, 1921, these figures were 80,900 and £17,800,000 respectively, representing an increase of 11 per cent. in the former and of 214 per cent. in the latter. In January last the number was 72,500, a decrease of 0.7 per cent. over pre-war figures, and the salaries and wages this year, assuming that the staff remains at that figure, will be £13,000,000, or 120 per cent. over those of pre-war days.

* Not reproduced.—Ed. The E.

Railway Matters.

THE railway companies have given further consideration to the question of reductions in railway rates, but in view of the present unsettled state of the engineering trades, have felt it necessary to postpone their decision.

ANSWERING a question on the 27th ultimo, Mr. Chamberlain said that it would be necessary to appoint another Minister of Transport, though the post would carry no salary. He was not in a position to add to what had been said as to the status of the Ministry of Transport being altered.

A HISTORICAL freight car was recently destroyed in the United States by the explosion of a case of dynamite. It was the first car, made of metal, to be used in the Southern States, and was commandeered by General Sherman to carry ammunition in his advance on Atalanta in the Civil War. It belonged to the Nashville, Chattanooga and St. Louis Railroad.

THE most powerful locomotive, without exception, on British railways, made its appearance at King's Cross this week. It is Mr. H. N. Gresley's latest three-cylinder Pacific No. 1470. She has 6ft. 8in. drivers, over 41 square feet of grate area, and nearly 3500 square feet of heating and superheating surface, and weighs, engine alone, nearly 93 tons. She is to be used for heavy passenger traffic, and brought in two sleeping cars built on Mr. Gresley's twin design—that is to say, the two coaches are carried on three bogies. We propose to describe both the engine and the new cars in our next issue.

A VERY happy phrase was used the other day by Mr. Oliver Bury, a director, and the late general manager, of the Great Northern Railway, at a smoking concert of that company's literary society. He said that the Great Northern locomotives were the greatest "die-hards" he had ever known. Many of his hearers, he remarked, would remember the single-wheeled engines designed by Mr. Patrick Stirling, and how they hung on year after year, but eventually had to give place to engines designed by his old friend, Mr. Ivatt. Now Mr. Gresley was about to introduce some new monsters, all his own.

SECTION 24—our official notice says Section 26—of the Railways Act ordered that two panels were to be constituted. One was to be a general panel consisting of twenty-two persons nominated by the President of the Board of Trade as representative of trading interests, twelve to be nominated by the Minister of Labour as representative of labour and passengers, and two by the Minister of Agriculture and Fisheries. The other panel was the railway panel, to consist of eleven persons nominated by the Railway Companies' Association and one representative of railways and light railways not subject to the Association. It is now announced that these panels have been completed.

IN this column of our issue of January 20th, we quoted from a letter written by Mr. Arthur Neal, in which he said that it had been agreed that the companies might omit from their reports for 1921 Abstracts A, B, C, D E and F. At the recent meeting of the Midland Railway Company, the chairman stated that he hoped that the shareholders did not think that the directors desired intentionally to withhold information from them. Such was not the case; it was only because the whole of the companies came to the definite conclusion that it would be undesirable to give information, which under any circumstances could only apply to 4½ months of the year's working included in the accounts, that the figures asked for had not been furnished.

THE chairman of the Mersey Railway Company said at the recent annual meeting that the installation of automatic signalling between Liverpool Central Station and Birkenhead was completed, and had been in operation for several months. It had proved itself to be of importance in increasing the capacity of the train service and maintaining its punctuality, and provided an additional safeguard against the risk of accidents. As showing the truly remarkable standard of punctuality which had been attained, the records showed that for many days together the train service had run from morning to night without having a single train more than one minute late. This showed that the plant was doing its work efficiently, and it reflected great credit upon the organisation and the members of the staff who were taking part in the operation.

A RESOLUTION authorising the raising of a loan of fifty millions in the United Kingdom for the use of the Government of India gave rise to an interesting debate in the House of Commons on the 29th and 30th ultimo. Lord Winterton said on the 29th that as to the purchase of railway material for India in this country, he had to consider the economic and general interests of the people of India. But the widest publicity practicable would be given in this country to the fact that rolling stock was required, and tenders would be considered from whatever source they were received. In the interests of the people of India, however, they must buy in the cheapest market from which satisfactory supplies could be received. He had no doubt that in this case, as in the past, large orders would be given to this country owing to the quality of English goods, their efficiency, and the times of delivery, but he could not give a pledge to that effect.

THE inauguration of the railway councils on the London and North-Western Railway and the winding up of the conciliation boards of the London and North-Western, North London, and Lancashire and Yorkshire companies was attended by an interesting ceremony on the 28th ultimo, in which Mr. Arthur Watson, the general manager, and Mr. J. H. Thomas took part. Of the 114 members on the first board, formed in 1907, 54 remained to the end. Mr. Thomas said he believed that in days to come those present would look back upon the day of the inauguration of the new scheme as a red-letter day in the history of railways. Mr. C. T. Cramp, the industrial secretary of the National Union of Railwaymen, spoke in eulogistic terms of the spirit which existed in the management of the London and North-Western Railway, and Mr. Watson, thanking them in reply, intimated that it was his wish that there should be full co-operation in working the new scheme.

Notes and Memoranda.

ACCORDING to a contemporary, Professor Reichel has designed a super-station which is to be equipped with six 160,000 k.V.A. units, and to have an annual output of 2000 million units. The proposed station would contain 100 steam boilers, each having a heating surface of 10,750 square feet and producing steam at a pressure of 285 per square inch. The total weight of each generator would be about 600 tons.

THE Hidroeléctrica Española, the second most important company in Spain, has nearly completed the construction of its station at Dos Aguas, the junction of the rivers Jucar and Gabriel, to the south-west of Valencia. This station will give some 100,000 horse-power when completed, and will no doubt help to improve the inadequate power and light service of Madrid, where the demands have increased so enormously in the past few years that the existing stations are quite insufficient to meet the requirements. The problem in Madrid is certainly very acute, and it appears within the bounds of possibility that a large steam power station will have to be erected to make the city independent of power stoppages caused by inadequate rainfall.

AN account is given in the *Engineering News Record* of the lining of an irrigation canal in America with 1½in. of concrete, by means of which leakage was reduced from 2.79ft. of depth per twenty-four hours down to 0.26ft. Expansion joints in the concrete lining, provided on the side slopes only, at intervals of 6ft., are made as follows:—After the surface has been given a final finishing, the concrete is cut through by means of a pointing trowel guided by a straight edge and the joint thus made is smoothed by a sidewalk jointer. The mixture of concrete used for lining is 1:7 and the average thickness of the lining is 1¼in. Lining of this thickness placed in 1911 and in use since that date is in excellent condition, demonstrating the durability of this thickness of lining in this locality where mild winters prevail with a minimum temperature of 25 deg. Fah. above zero.

IN 1915 there were 329 water-power establishments in Italy of over 300 horse-power, which developed a total force of 935,000 horse-power. In 1920 there were 383 similar establishments developing 1,152,120 horse-power, and 54 (359,210 horse-power) were under construction. There were also 300 establishments of under 300 horse-power, representing a total force of 300,000 horse-power. In addition to the above, there are several large schemes in hand which will not be completed for some time. These include the artificial lakes in the valleys of the Reno and the Imentra, in the Bologna district, which will be used in connection with the electrification of the trans-Apennine railway between Emilia and Tuscany; similar work in the Abruzzi; the Silani lakes in Calabria, and the Tirso lakes in Sardinia. These schemes are calculated to produce 700,000 horse-power. The artificial lake at Tirso, it is said, will have a capacity of 416 million cubic metres, and will be the largest in Europe, and the third largest in the world.

ACCORDING to the *Electrical World* recent tests made on the 60,000-kilowatt cross-compound, triple-cylinder steam turbine installed in 1918 at the Seventy-fourth-street station of the Interborough Rapid Transit Company, show that a steam consumption of 11 lb. per kilowatt-hour can be obtained under normal conditions. With the high-pressure turbine and one low-pressure turbine in service, the lowest consumption was 11.25 lb. per kilowatt-hour. When operating in this way the consumption is better than that for the complete set at loads below 25,000 kilowatts. The 60,000-kilowatt turbine is of the Westinghouse type, and consists of one high-pressure and two low-pressure elements, each element driving a separate generator. The normal steam pressure at the throttle is 220 lb. absolute with a superheat of 150 deg. Fah., and the machine exhausts into a vacuum of 29in. referred to a 30in. barometer at 58.1 deg Fah. The speed of all three elements is 1500 revolutions per minute.

PEELED timber is more durable than unpeeled timber, and it is stated by one authority that the life of timber placed in dry mine workings may be increased 10 to 15 per cent. by peeling. Bark acts as an impervious coating and retards the loss of moisture from timber, thus making the conditions more favourable to fungus attack. It also offers an excellent breeding place for many wood-destroying insects, which not only weaken the timber but cause it to decay more rapidly. Other considerations favouring peeled timber are that it usually is less inflammable than unpeeled timber, and where it must be shipped for any considerable distance by rail the peeling at the point of shipment will effect a saving in both freight and cost of handling by reducing the weight from 6 to 10 per cent. of the original green weight. Furthermore, timber which is to be given a preservative treatment must be thoroughly peeled before it can be successfully treated. Even a slight amount of the inner bark adhering to the timber will often cause imperfect treatment results.

IN a letter to *The Times*, Mr. A. A. Campbell Swinton states that in addition to David Hughes' notebooks containing an account of his experiments in wireless telegraphy in 1879, which have recently been bequeathed to the British Museum, the Museum has acquired a further set of these notebooks, containing Hughes' own illustrated account of his invention of the microphone. "Still more interesting," states Mr. Swinton, "is the fact that a search, suggested by myself to Colonel H. G. Lyons, of the Science Museum, made amongst the contents of a room full of Hughes' personal effects that for the last twenty years have been stored in a furniture repository in London, has revealed the existence of a number of electrical instruments, comprising the original first microphones invented by Hughes, and the actual apparatus with which he made his early wireless experiments, all obviously constructed with his own hands. The several instruments can easily be identified by the illustrated descriptions in the notebooks, and we thus have a collection of great historical and scientific interest, which, through the generosity of the Hughes' trustees, has been presented to the Science Museum in South Kensington, where it will shortly be on public view."

Miscellanea.

THE current number of *Modern Transport* is given up almost wholly to traffic and transport at Bristol and Gloucester. In making this announcement, we congratulate our young contemporary on the fact that it has passed through the most difficult period in the life history of a newspaper, and is now entering upon its fourth year.

THE work on the Alfonso XIII. Canal in Spain has proceeded more slowly than was expected. The foundations of the new quays on the left bank and also of the bridge at the Seville end are now complete, but a lot of work remains to be done, and the Canal will probably not be open for navigation before the middle of 1923.

THE official organ of the Industrial League and Council makes its appearance in new form this month under the title *Current Opinion*. The principal articles are "An Industrial Parliament," by Mr. J. R. Clynes and Sir William Noble; "Waste in Industry," by Professor Spooner; and a special supplemental article on "Fair Play," by Mr. James Smith.

ACCORDING to the *Journal* of the British Chamber of Commerce, Shanghai, the working of the Hunan cotton mill shows a great improvement, and the mill is beginning to make a fair profit, although only about half the spindles are at work. New machinery, intended to bring the remaining spindles into operation, has been ordered from England through a British firm. Other mills, of about 10,000 spindles each, have also made inquiries for British machinery.

A REPORT from Washington, dated April 4th, states that a treaty with Great Britain is under consideration, under the terms of which the United States and Canada would be empowered to begin work on the construction of the proposed St. Lawrence deep waterway. It appears that there has been some conflict of opinion regarding the best method of procedure, and the negotiation of such a treaty would, it is felt, compose these differences and greatly advance the project.

A MESSAGE from Helena, Arkansas, dated March 31st, stated that strong floods were crumbling the levees on the Mississippi River at the old town, and that conditions were becoming critical, while the heavy rains were interfering with the engineers' emergency tactics. A section of the Missouri-Pacific Railway was already under water, and river boats had been arriving at Vicksburg during the preceding three days overloaded with passengers and livestock which had been rescued from threatened places.

IT is proposed to hold a meeting of engineers of all ranks who served with the Egyptian Expeditionary Force and in Gallipoli during the war, at the Engineers' Club, Coventry-street, London, W., at 6 p.m., on April 19th, that being the anniversary of the second battle of Gaza. An inaugural dinner, at which attendance is optional, will follow. The primary object of the meeting is to render any possible assistance to those who may be in need of it in these critical times. A fund is being opened, and subscriptions are invited to assist those to attend who may otherwise be unable to do so. Communications may be addressed to Captain H. J. W. Oxlade, 28, Victoria-street, S.W. 1, marked "Gaza Dinner."

IN the course of the annual report of the Committee of Management to the members of the Manchester Steam Users' Association, it is recorded that the total number of examinations made during the year was 23,383, this being the highest on record. It is with satisfaction that the Committee is able to state that during the whole course of the Association's existence no preventable explosion has ever occurred of any boiler which the Association has inspected and guaranteed as safe. The report emphasises the great importance of boilers being submitted annually to careful, thorough inspection, since it is only by this means that immunity from explosion can be secured. The imperative need of such regular inspection cannot be too strongly urged in these days of increasingly large units and high pressures. The rigid adherence to an annual "thorough" inspection is the practical carrying out of the object of the founders of the Association, viz., the prevention of explosion by efficient and regular inspection.

AS the result of satisfactory negotiations between the Oldham and Rochdale corporations and the directors of the Rochdale Canal Company, a Bill is to be promoted during the ensuing session of Parliament, by which the Corporations will seek powers to acquire the water that is surplus to the company's present requirements for the joint use of the two Corporations. The proposal is that the whole of the reservoirs and appurtenant works, together with the water rights and powers of the company to construct additional reservoirs, shall be acquired by the Corporations, which will make arrangements for supplying water for the working of the canal, in addition to the statutory compensation to the streams. It is expected that the Corporations will obtain about 2½ million gallons per day from this scheme, which quantity will be divided between them in proportion to the population which each town supplies. The reservoirs, which are seven in number, have a total storage capacity of 1,530,000,000 gallons, and a drainage area of 4936 acres.

IN a paper on the "Structure of Fuels," which was read on Monday last before the Society of Chemical Industry, by E. R. Sutcliffe and Edgar C. Evans, the authors stated that they had come to the conclusion that the free-burning property of a fuel was due not so much to its composition as to its structure. They pointed out that no improvement had taken place as regarded fuel consumption in connection with British blast-furnace practice for practically fifty years. With coke of the type used at present, very little improvement was, they said, possible, even in the most modern plants working on British ores, and they pointed out that the late Sir Lothian Bell had definitely stated that a minimum consumption of over 20 cwt. of coke per ton of pig iron was absolutely necessary with Cleveland ores. The authors, however, hoped that, with a coke of a different type, that figure could be considerably reduced, and they anticipate that it would be possible to produce 1 ton of pig iron with an expenditure of only 12 cwt. of coke by the use of a new fuel of the type which they discussed.

SIX-TON UNDER-TYPE STEAM WAGON

RICHARD GARRETT AND SONS, LIMITED, LEISTON, ENGINEERS

(*For description see page 384*)

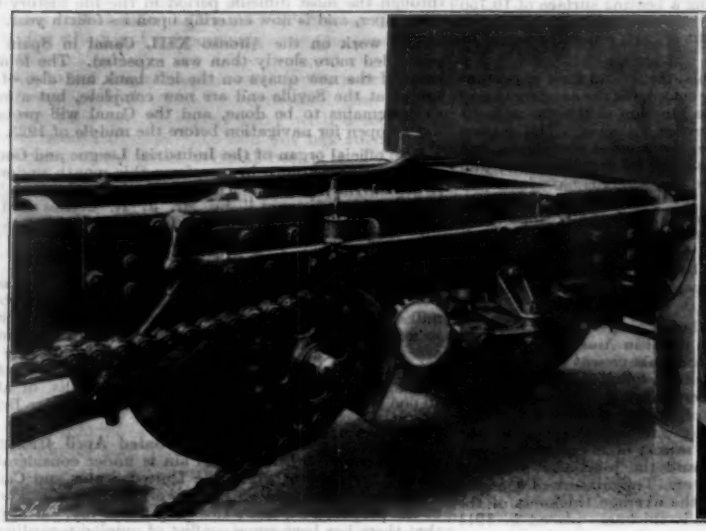


FIG. 3—CHAIN DRIVE ON OFF SIDE

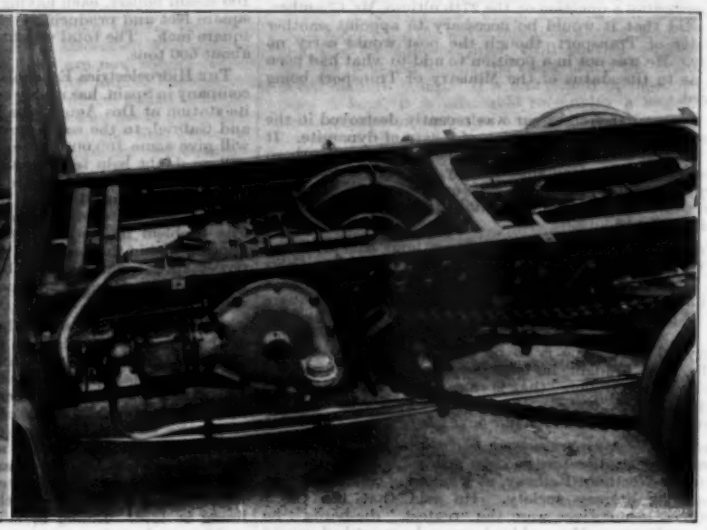


FIG. 4—FEED-PUMP, NEAR SIDE

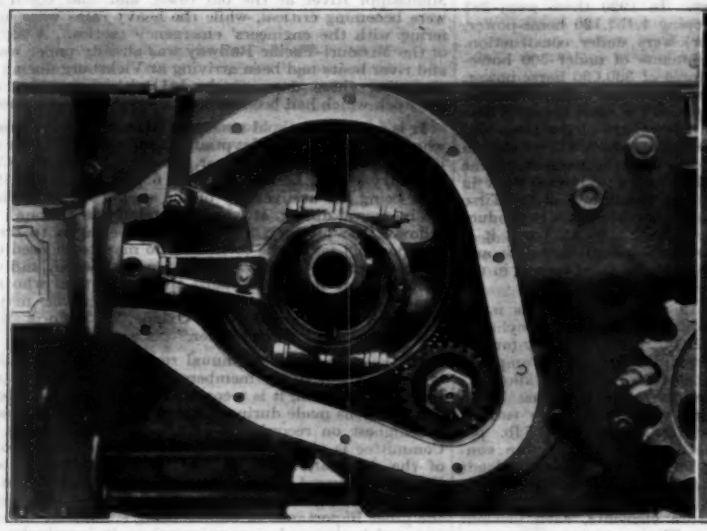


FIG. 5—FEED-PUMP GEARING

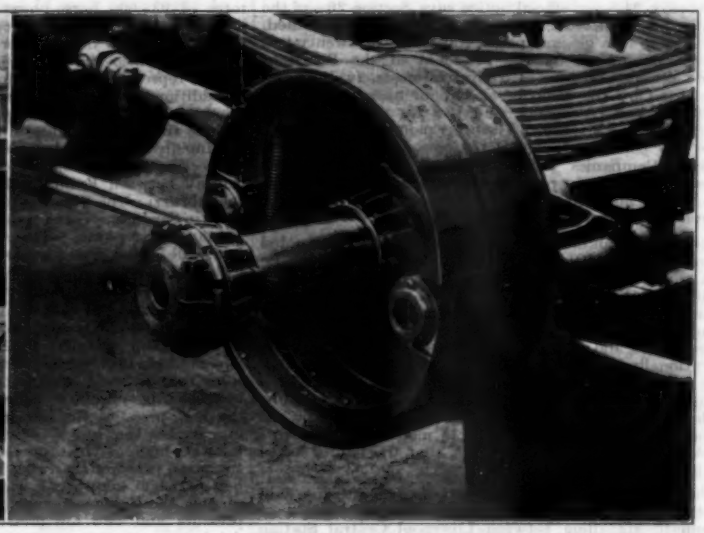


FIG. 6—BRAKE SHOES

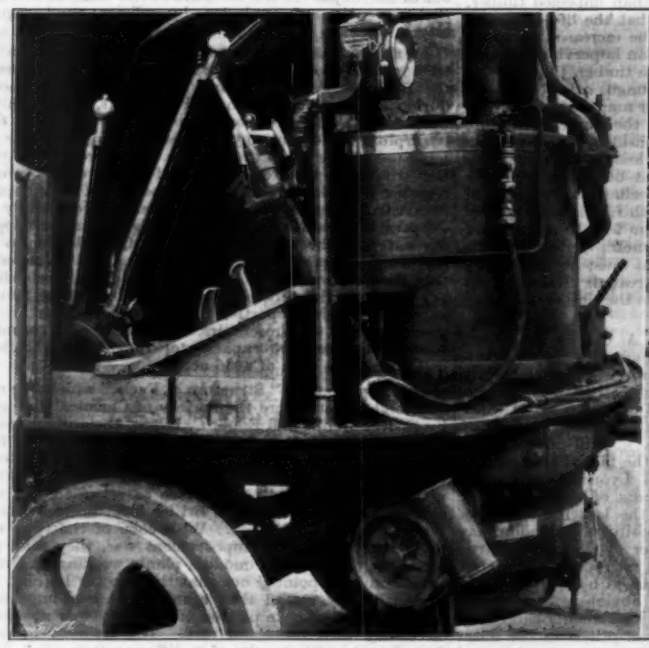


FIG. 7—BOILER, DRIVER'S SIDE

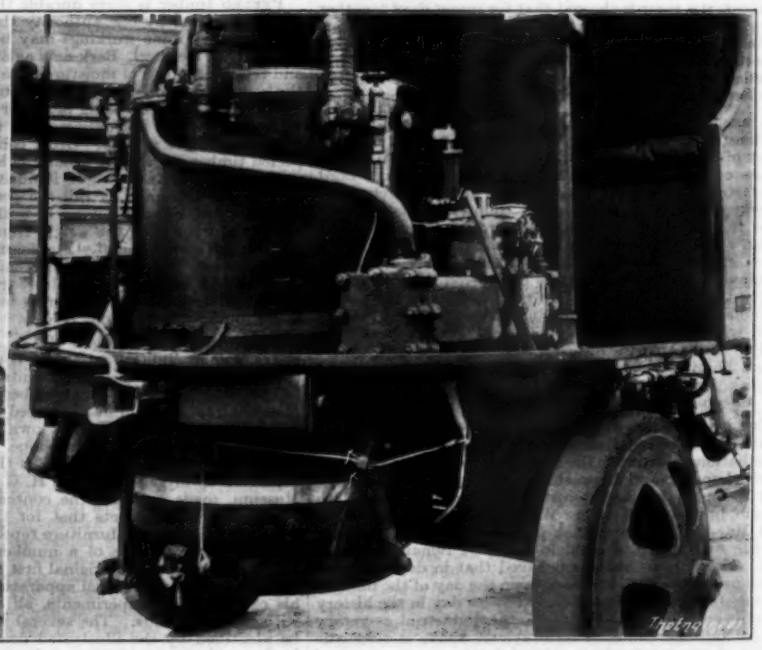
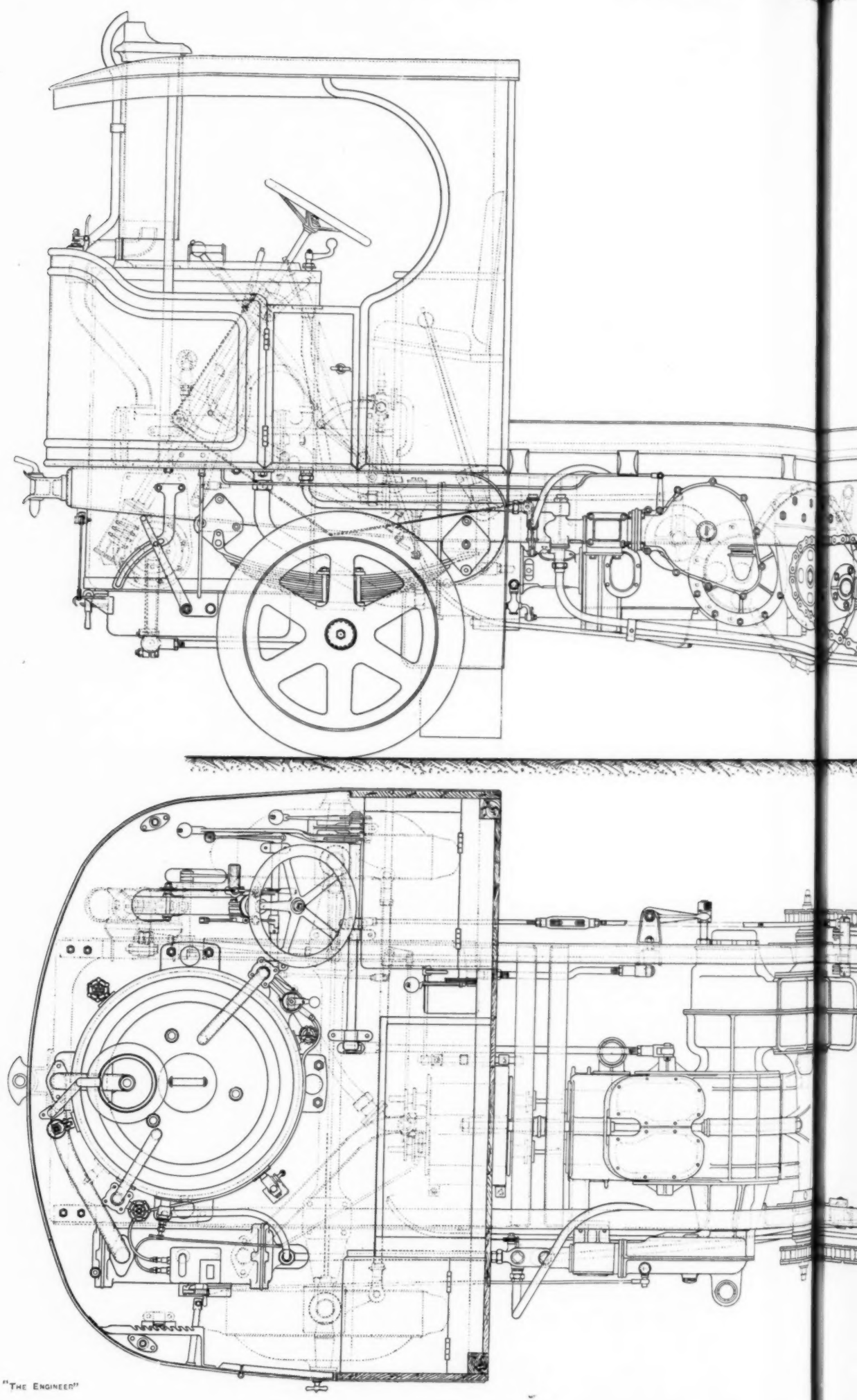


FIG. 8—BOILER, FIREMAN'S SIDE

SIX-TON UNDERT E

RICHARD GARRETT AND SONS, L D, LE



"THE ENGINEER"

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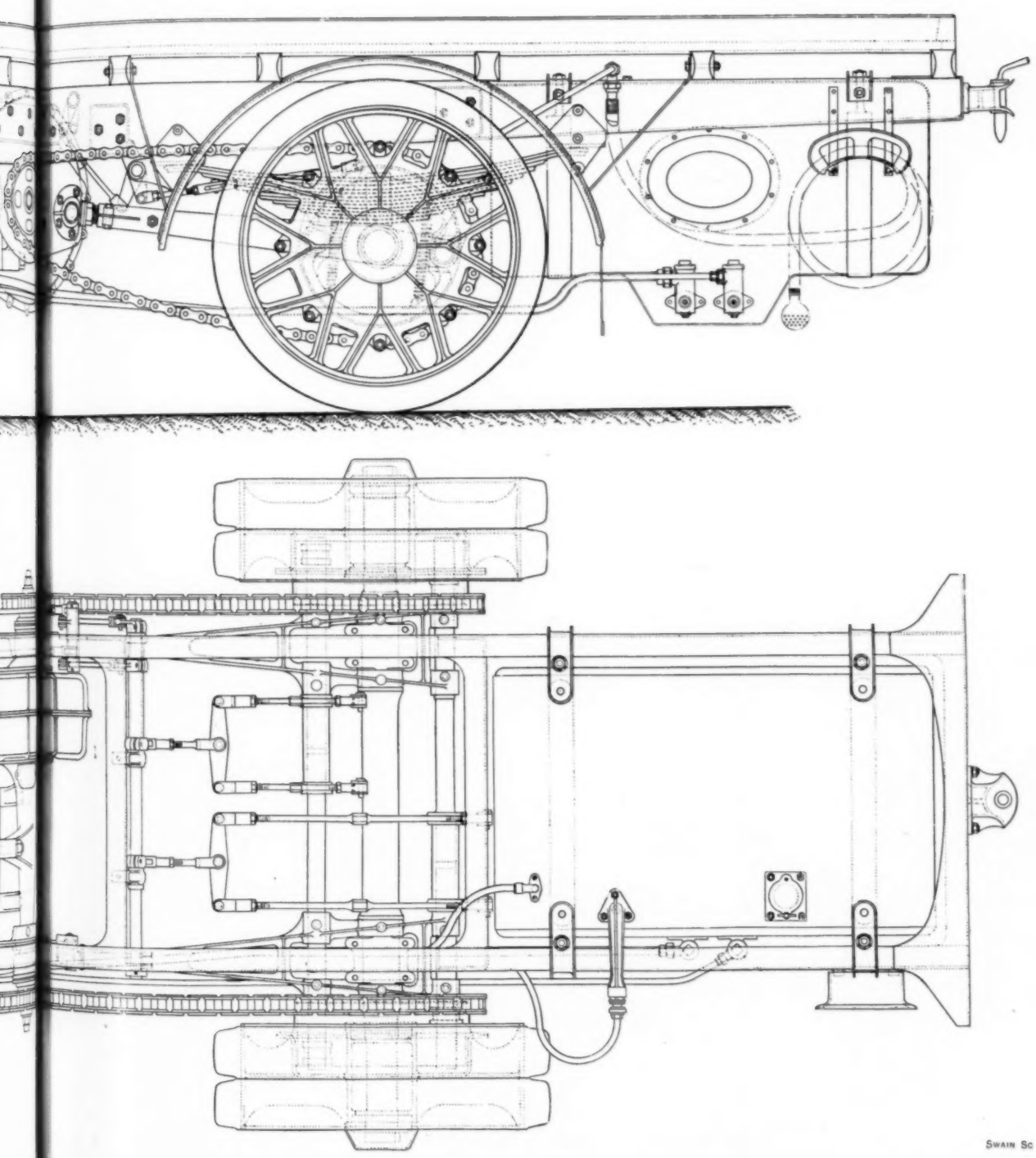

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

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PUBLISHER'S NOTICES.

*** *With this week's number is issued a Two-page Supplement illustrating a Six-ton Undertype Steam Wagon. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

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TO CORRESPONDENTS.

*** *All letters intended for insertion in* The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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Two-page Supplement—Six-ton Undertype Steam Wagon.

THE ENGINEER.

APRIL 7, 1922.

Science and Labour.

Amongst the letters on industrial problems which have appeared in our correspondence columns during the past few weeks may be found one in which it is urged that, rather than reduce wages, employers should increase the rate of production by the adoption of improved methods of manufacture. "If only," says our correspondent, "they (the employers) would set about reducing manufacturing costs by reconstruction of works administration, by cheapening design, and by countless other internal economy schemes, and leave wages at a fair level, surely it would bring about their desired results, and save a deal of trouble later on." He gives us an example from his own experience. "In a large and well-known establishment, I held a post as checker in the works drawing-office, composed of eleven designers. One of the best instances of ridiculous waste of time took place here. There was a checker of designs and figures, a chief draughtsman, a works drawing-office superintendent, and a works superintendent. Every jig or tool lay-out came from the designer to the checker, from him to chief, on to the works drawing-office superintendent, who consulted the foreman for whose department the design was intended. It would then go to the works superintendent for approval. Can anyone imagine such a preposterous system?"

This example opens up a problem which we may assure our correspondent is not overlooked by employers. The works organiser—that modern product who takes over many of the duties of the manager to leave him with more time to wrestle with the trades unions—would see little remarkable in the routine described. Indeed, he would perhaps go further and commend it. He would point with enthusiasm to the neat partitioning of the duties and would perchance fall into ecstacies over the forms, schedules, dockets, index cards, &c. &c., that would make the simple transaction a work of organisational art. He would claim that it was right that the work of the designer should pass through a checker, and by him be handed to the chief. That the chief, who ought not to be troubled about shop affairs, did well in handing it to the works drawing-office superintendent, whose duty it was to run about the shops interviewing foremen on the practicability of the design, and who, having satisfied himself, would, of course, have to seek the approval of the works superintendent himself. That course of events, we say, would appear very right and proper to the scientific works organiser. Our correspondent appears to imagine that it was exceptional, and he exclaims against it as a "preposterous system." We have no doubt whatever that thousands more like it could be found, and that far from being preposterous, it is in accord with the principles that have gained much ground in recent years. But against such over-systematising, there are signs of rebellion. Employers are beginning to inquire if the multiplication of non-productive staffs is really necessary, and are beginning to seek means of dispensing with some of their routineers as Government offices, under public pressure, have already had to do. We put to works organisers this simple proposition: If there is any member of the staff who is not earning at least five per cent. more than he or she is costing in salary, office room, lighting and general equipment, then that person is a burden on the factory and should be dispensed with. That in passing. Let us turn now to the more important matter covered by our first quotation. To begin with, we must repeat, what we have so often said, that employers do not want to reduce total earnings; what they want to do, what they know they must do, is to reduce the wages cost per piece. Our correspondent assumes that if employers would improve their methods, that object could be achieved without reduction of the wage rate. We agree with him, but we would ask him to agree with us that it could also be achieved by the men working harder and by the removal of all those restrictions on output which the trades unions have opposed. As far as employers are concerned, we do not think they are generally disposed to neglect methods of increasing economy. It must be remembered that manufacturing employers work always on piece, never on day wages. The cheaper and more numerous their products the more they can earn, and for that reason they adopt as far as they can economical methods. The workman on piece has the same stimulus, and he is generally just as eager for economical methods as the employer. One of the claims made by Mr. Rowan for his premium system was that it caused the men to insist on improvements being carried out by the management. It is the unions that are opposed to piece-work, on the principle that the more any one man does the more he deprives another of his means of livelihood. The object of the union is to keep as many men as possible in employment; the object of the employers is to use as few men as possible *for a given output*. Could we reconcile that difference, many industrial problems would vanish. There is, we hold, no greater duty before economists than to show definitely and finally that the doctrine of restriction of output is false, and that the introduction of labour-saving appliances and methods leads inevitably to the multiplication of the total number employed, and to the gross wages per worker, whilst reducing costs and increasing markets. The facts exist, but they need the hand of a great economist to reduce them to order and to exhibit in a manner that will convince the most obstinate of reactionaries that only along such lines can progress be made.

We have dealt with the plea made by our correspondent because it is one not uncommonly met with. Many eyes are turned upon science and research in the hope that they can ensure the industrial prosperity of Great Britain. On this point it is well to be quite positive. Without scientific industrial progress we are doomed; but scientific industrial progress cannot, alone, save us. We may cheapen and accelerate the production of a commodity by the discovery of a new process or the improvement of an old, but, it is as certain as the day that every competing nation will in a short time use and enjoy the advantages of that process. It is only by advancing on all fronts at once that we can hope to maintain our position in competition with other industrial nations. We must have science, we must have low labour costs *per piece*, and we must have wise management and economical organisation. These three things hang together. Any one of them alone cannot assure our industrial stability, we must have all three. Science must present us with the best methods of manufacturing, labour must welcome those methods and withdraw its resistance to them, and administration must direct as economically as it can the joint efforts of science and labour.

Electricity on the Farm.

Sooner or later electricity will, in all probability, play an important part in agriculture. Much has already been done in the way of electrifying farms on the Continent and elsewhere, and although it cannot be claimed that the work that has been undertaken in this country can in any way compare, from the point of view of magnitude, with that which has been carried out abroad, the possi-

bilities of further developments in this direction are not altogether being ignored. Mr. Borlase Matthew's paper on "Electro-farming, or the Application of Electricity to Agriculture," which was read before the Institution of Electrical Engineers last week, and which is published in abstract on another page of this issue, throws a good deal of light upon the scope which the farming industry offers to electrical engineers who are anxious to exploit every possible field of business. The paper was presented in a manner which should have aroused enthusiasm, for with the aid of the cinema, Mr. Matthews showed on the screen many kinds of farming machinery at work, yet the discussion, as far as it went, was for the most part distinctly pessimistic. Even Mr. Ll. B. Atkinson thought that the introduction of electric motors on farms presented difficulties, whilst Mr. M. B. Jenkin—who, like the author of the paper, is the owner of a farm—saw little or no reason why existing methods should not be adhered to. It was freely admitted that as the small oil engine meets many of the farmer's requirements remarkably well, it will be no easy matter to displace it. Other obstacles were considered to be the small amount of time which some farming machines are required to work during the course of the year, the objections to wires and cables in fields, and the small and unprofitable amount of current which is required for electro-culture. The discussion was not, however, completed. Many members were, it seems, down to speak at an adjourned meeting, which at the time of writing has not been held, and it is therefore scarcely fair to base the general trend of opinion on what was said in the short time at the disposal of the members after the paper had been read.

Unless electrical engineers have really made up their minds that they do not want to be bothered with the agricultural industry, the tone of the next discussion will, we fancy, be somewhat different from that of the first. The remarkable progress which has been made in other countries, such as Germany for example, surely ought to be taken into account. If the long-promised cheap supplies of electricity were available in the rural parts of this country, there is not much doubt that agricultural loads would be secured. At present the farming areas which have access to electricity supplies are not by any means numerous. Enthusiasts like Mr. Matthews will argue that the farmers need not wait for these supplies, as they can quite well generate current themselves, but that policy is not likely to be pursued to any marked extent. The provision of current at low prices and active propaganda are the two main things which electrical engineers must provide, if they desire to do business with the agriculturist. In the farming industry, we believe, electrification is often thought to imply nothing more than electro-culture or the stimulation of the growth of crops. So much has been written about this side of the subject that the other applications of electricity are often overlooked. What the average farmer's opinion is of electro-culture we have no idea. Electrical investigators claim, however, that it is distinctly beneficial. An electrically treated crop, it is asserted, may be relied upon to produce at least 10 per cent. more grain with a proportionate increase in the amount of straw. Against this gain, however, must be set the cost of the electrical equipment, which unfortunately is a rather formidable item, but the current required for the process is small, so small, in fact, that electro-culture is generally considered to be of no interest to supply authorities. It is, however, we think, a mistake for those who may wish to sell current to the agriculturist to pay too much attention to the value of his initial demands, for if it can be shown that a small amount of current will increase the growth of crops, it is not at all improbable that more current will very soon be needed for other purposes. The growth of the use of electricity in all industries, it is to be remembered, has been more or less gradual. Many a manufacturer has purchased one or two motors by way of experiment, and has been so pleased with their performance that he has ultimately electrified the whole of his factory. The first step towards the electrification of farms should, it seems, be the lighting of farm buildings from transmission lines passing through the rural districts. Having demonstrated to the farmers the advantages of electric light and possibly also those of electro-culture, it should then be a relatively simple matter to get them to try a little electric power, and possibly a little electric heat, and so ultimately bring about the happy state of affairs which Mr. Matthews portrays in his paper.

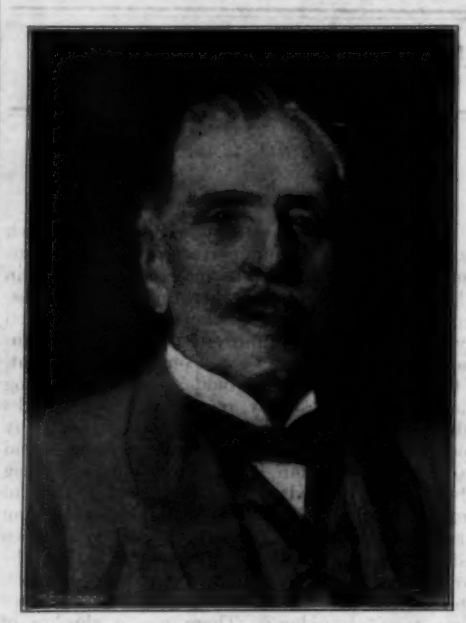
It will, however, probably be a long time before the makers of agricultural engines find themselves in real competition with the makers of electric motors, especially if the apathy to which we have alluded continues to prevail. Cheap supplies of electricity in the farming areas may not materialise for some years to come, and in the meantime the oil engine will have gained a still firmer footing. But there is little doubt that electricity will sooner or later acquire favour in the British farming industry, as it has already done abroad, for apart altogether from the question of driving machinery, it may be utilised with marked advantage for lighting, for heating incubators, for the sterilisation of milk, and for the preparation of electrolytic ensilage.

Obituary.

JAMES N. PAXMAN.

A Personal Note.

It is the fate of most of those who live beyond the common span of men to see their victories forgotten and to feel themselves known only to a few outside a generation which is slipping away beside them. So it was with James Paxman, who died last week in his home at Bournemouth at the age of ninety. His work began at a time when few engineers now living had left the nursery, and it ended—if end it ever did—before the younger engineers knew their alphabets. He was born—in Colchester—when mechanical engineering was still a wonder to the world, only a few years after the steam locomotive had found itself,



JAMES N. PAXMAN

twenty years before the industrial possibilities of electricity began to be seen, and well-nigh fifty before those possibilities became actualities. His career began in 1851 when he was requested by Mr. Charles Marriage—another name famous in Colchester—to assist him in the management of the small engineering business of Catchpool and Son. He was then only nineteen, and when, two years later, Mr. Marriage left Colchester, he, then barely of age, managed the works alone. Well may the keen student of to-day look back on the chances that fell in the way of youths two generations ago! Young Paxman threw himself with zeal into the making of little steam engines and boilers, and established the works on a sound foundation. Those of us who knew him in later years and saw the inexhaustible energy he retained, even when in years he might be counted an elderly man, can imagine what he was in the ardour of youth. Whilst with Catchpools he was entrusted with the interesting work of fitting twin-screw engines of his own design to a steam tug on the Essex Stour. That was in '61. A few years later, 1865, he entered into partnership with Messrs. C. M. and H. M. Davey. The firm took shops in Culver-street, where Mumford's works now stand, and flourished so greatly that in 1876 a larger and more convenient site was sought. One was found at the Hythe, and much closer to the river than the original works. It was there that Paxman's chief work was carried out, for two years later the Daveys retired from the business, and the subsequent development of the firm was due, in the main, to him.

Were we dealing with the firm or with its products and not with its founder, we should have a long list of successes at shows, exhibitions and trials, to say nothing of private contracts, to record, for the firm made and sustained a fine reputation. James Paxman, whilst still at Culver-street, had "struck oil" with his vertical boiler, and in later years he repeated that success with the Economic, a dry-back marine type steam generator. But it was not so much the inventions themselves as the energy he expended on their development that made them profitable. If ever a man took endless pains, it was James Paxman, if ever a man inspired others by his own activity and fired others with his own enthusiasm, it was he. For many years he lived a stone's-throw from the works, and he was in and out of them at all hours. Nothing escaped him. He knew not only every thing about his factory, but every man and boy in it. No master was ever more loyally served, and no master ever deserved it more, for he never asked his people to make an effort without making it shoulder to shoulder with them. If there was a boiler to test, he was there to see that all went well, and handle the shovel and the dampers himself; if there was an engine to complete for an important competitive trial, he might be seen at any hour, with his coat off, working at it himself and inspiring others by his example; If there was an order to be got, he was the man to get it, and many are the stories of his skill in that direction. At the famous trials of portable engines by the Royal Agricultural Society in Newcastle, he himself stoked his own engine to victory. His firing is a tradition to this day. He used a shovel which, as the story goes, was no more nor less than one of those with which the banker shovelled up sovereigns. The coal broken to a proper size was beside him in a heap, and taking up a shovel full he whipped the furnace door open, shot the coal in just where it was wanted, and snapped the door to again as one might shut the breech of a *soixante-quinze*. Some said it was not fair firing, but Paxman was out to show what his engine and boiler could do when used in the best possible manner and with the highest fireman's skill, and he attained a figure which even to-day cannot be excelled.

It was this characteristic thoroughness that led him from success to success, this thoroughness backed up by an untirable constitution and energy which seemed inexhaustible. With the coming of electric lighting, he identified himself by providing engines fitted with his speed regulator, which met the requirements of the day, and the name of his firm was well known at many exhibitions lighted electrically after the early 'eighties. He was always advancing with the times, always ready to seize occasion and make the most of it. Always the merchant as much as the engineer. No man knew better than he that it was no good making if you could not sell, and no man knew better how to sell what he had made.

We like to look back on the life of James Paxman because it presents such a contrast with the lives of the greater manufacturing engineers of to-day. In his own best period, between the ages of forty and sixty or so, he had not more than 300 to 350 men in his employment. He knew them all, and knew exactly their merits and their failings. He was a "master" in the days when workers did not see anything derogatory in that ancient office. He had the natural talent for leadership. He blended with a stalwart intellect great strength of mind and much kindness of heart. It is with these qualities that men draw others after them. He had confidence in himself, and inspired the confidence of others, and his tact never failed him. As an example of what engineering masters were thirty, forty, fifty years ago, we may look back upon James Paxman with respect. There were, fortunately for England, many like him, and one cannot help, in the present age of vast concerns, repress some regret that the days of the individualist in the engineering industries are passing rapidly away, and, indeed, have almost gone.

Almost to the last he remained in close touch with the business of his company, though failing health obliged him to live far from the works. In all that it did he took the keenest interest, and he not only followed, but assisted it in its progress. Truly a remarkable man. Not a great engineer in the sense of a Watt or Whitworth, but a great manufacturing engineer, who did not a little to maintain and extend the reputation of British mechanical engineering at home and abroad, and, above all, that type of "master" that is now but rarely found, and will soon be unknown.

SIR WALTER CHARLETON HUGHES.

We record with much regret the death, on March 30th, of Sir Walter Hughes, C.I.E.

Walter Charleton Hughes was born on September 22nd, 1850. He received his early education first at private schools and afterwards at King's College, London, of which, by the way, he in after years became Fellow. In 1868, at the age of eighteen, he went out to India to take up an appointment with the Bombay Public Works Department. During the next nineteen years he saw service in various districts, and in 1887 was made secretary to the Government of Bombay in the Department, a post which he held until 1892. During the period 1892–1898, and again from 1900 to 1910, he was chairman of the Board of Trustees for the Port of Bombay; and from 1898 to 1910 chairman of the Bombay Improvement Trust. That is a bald record of what was in reality a period of forty-two years of strenuous work, in a peculiarly trying climate. During it the Port of Bombay grew from comparatively small dimensions into a shipping

centre of first importance, and in the development Sir Walter played a leading part. Prior to 1858 Bombay had no wet dock. The trade of the port was carried on by means of open-ended tidal basins constructed at right angles to the shore line. In that year the Elphinstone Company was formed to acquire what had up to then been a number of small undertakings and to consolidate them into a homogeneous whole. The new company did well at first, and was considerably aided by the outbreak of the American Civil War in 1861, which brought about an abnormal call for cotton from India. Bombay had a time of extraordinary prosperity, in which the company shared, and it spent more money on improvements than was actually warranted. Getting into financial straits in 1867 it applied to the Government for a loan. Its request was refused, and, instead, a Port Trust to acquire the undertaking of the company and other smaller properties was constituted. The new body was not, however, brought into being till 1873, five years after Hughes had gone to India. One of the first constructional works of importance which it carried out was the Prince's dock, which had an area of 30 acres. That dock was followed by the Victoria, which is alongside it, and which is of 25 acres in extent. It was completed in 1888. Exactly how far Sir Walter was concerned in these works we do not know, but for subsequent developments the initiative was certainly very largely his, though the plans were actually prepared by Mr. P. Glynn Messent, M. Inst. C.E. The huge new Alexandra Dock, which has an area of 49.52 acres, nearly double that of the Prince's and Victoria Docks taken together, was designed and carried nearly to completion while he was chairman of the Trust. The dock is conspicuous in having an entrance lock 750ft. long by 100ft. wide, and a depth of water over its sill of 37ft. at high water of spring tides. There is also opening from the dock an enormous dry dock, named the Hughes, which is no less than 1000ft. long by 100ft. wide, figures which give some idea of the amount of foresight brought to bear in the design of the works. The foundation stone of the Alexandra Dock was laid by King George, when Prince of Wales, in 1905, but the work was not finally completed until early in 1914, just in time to be of incalculable service during the war. Sir Walter was not interested only in the Port of Bombay. He was largely concerned, too, in remodelling the city itself, and was responsible for a scheme of re-building congested areas which cost nearly five millions sterling to carry out.

Returning to England in 1910, Sir Walter entered the firm of the late Sir John Wolfe Barry, and still continued his connection with the Bombay Port Trust as consulting engineer. He also designed constructional and railway works for various parts of the world, including Russia, during the earlier years of the war. He was, too, for some time chairman of the company which acquired from the Government the port of Richborough with a view to developing it as a ferry port.

Sir Walter was made C.I.E. in 1900, and received the honour of knighthood in 1906. He was a member of the Institution of Civil Engineers, having been elected in January, 1885.

DR. A. McWILLIAM.

Dr. Andrew McWilliam, the well-known consulting metallurgist, and formerly Professor of Metallurgy in Sheffield University, died at Sheffield on the 5th inst. He had had twenty-four years' association with the city when, in 1911, he accepted the appointment of Head Metallurgical Adviser to the Government of India. Before his departure for India he was given the degree of Doctor of Metallurgy for his researches into the metallurgy of steel. For many years he was a most familiar figure at the Iron and Steel Institute meetings, and his numerous papers were always of a practical and suggestive character, and most welcome contributions. He was educated at Glasgow and the Royal School of Mines, London, where he obtained a first-class scholarship. At one time he was chemist to the Martino Steel Company, and then for two years lecturer in metallurgy to the Staffordshire County Council.

E. A. CLAREMONT.

The death occurred on Tuesday last of Mr. E. A. Claremont, M.I. Mech. E., M.I.E.E., chairman of the firm of W. T. Glover and Co., Limited, Trafford Park, Manchester and until recently of Rolls Royce, Limited, of Derby. Mr. Claremont was also chairman of Royce, Limited, and of the Trafford Park Power and Light Supply, Limited, until that undertaking was acquired by the Stretford Urban District Council. Mr. Claremont was fifty-eight years of age, and had been in indifferent health for some time, but his death came unexpectedly suddenly at Messrs. Glover's works as stated above.

It is understood that the Committee appointed by the Government of Bengal to advise regarding the new type of bridge across the Hooghly at Howrah has decided to recommend a fixed single span bridge at a cost of approximately two crores of rupees.

The International Railway Association.

No. II.*

Reinforced Concrete.

Subject IV. is concerned with the use of ordinary concrete and of reinforced concrete on railways, and the reporters are Mr. W. W. Grierson, chief engineer, Great Western Railway, for Great Britain; Mr. G. A. Haggander, bridge engineer of the Chicago, Burlington and Quincy, for America; Mr. P. M. Bülow, Danish State Railways, for Denmark, Sweden, and Norway; Mr. C. Leemans, Holland Railways Company, for Holland; and Mr. Golard, Belgian State Railways, for the other countries.

Mr. Grierson's report was reproduced in July, 1921, Bulletin, and of it we present a summary as follows:—Whilst reinforced concrete of one system or another has been considerably used both on the Continent and in America, its adoption in England appears to have been rather slow. Whether this cautious adoption of a new structural material is to be attributed to want of British enterprise or whether to justifiable doubt about the ultimate behaviour of the material, is an open question. So little reinforced concrete work has, comparatively speaking, been carried out by railway engineers in the United Kingdom, India, and overseas that it would not seem permissible to base conclusions of a definite character on the information collected, and the comments and suggestions contained in Mr. Grierson's report are, to some extent, of a personal character.

Foundations.—It is perhaps in foundations that reinforced concrete has most largely been used by British railways, either in the form of a floating raft foundation or as piling, and, on the whole, with satisfactory results. When driven in suitable ground and completely buried, reinforced concrete piles unquestionably have so far given complete satisfaction, and it appears reasonable to anticipate that in a position to which air is not accessible, or only to a very limited extent, deterioration of the reinforcement will not take place; moreover, piling of this kind, being subject to compressive stress only, possible deterioration of the reinforcement is not of great importance. The question, however, naturally arises whether any advantage results from the use of reinforced piles instead of timber, and the answer would appear to be that, whilst reinforced concrete piling is, on the whole, more expensive, it is capable of sustaining a much greater load, while its practical indestructibility in a buried state ensures for all time the permanency of the foundation; it has also the advantage of resisting insect attacks in countries where these are to be feared.

A recent careful inspection of an extension in reinforced concrete, made in 1911, of a wharf in Plymouth Docks shows that the piling, wallings and diagonal bracings are in a thoroughly sound state, both above low-water mark and below, as far as can be ascertained. The decking slabs are also sound; but, on the other hand, the longitudinal beams show marked indications of deterioration.

The Great Eastern Railway Company carried out in 1908 an extension to its Parkeston Quay at Harwich, 1000ft. in length and covering an area of 354,000 square feet. The structure is designed to carry 4 cwt. per super foot and the piles, which are 14in. by 14in., weigh 80 tons each. A feature of the construction is the enclosure of the front piles within concrete cylinders, 4ft. 6in. diameter, filled in with ordinary concrete. This provision not only protects the front piles, but also has the effect of adding considerably to the rigidity of the whole structure. A recent examination indicates that the piles, 1740 in number, as also the whole of the framing and decking and other members, are in a thoroughly sound state, with the exception only of the front beams running parallel to the quay and at a height of about 3ft. above high-water mark. The concrete on the underside of the beams in question has very badly deteriorated and the reinforcement is exposed.

Effect of Sea Water.—The action of sea water on concrete has, during recent years, received considerable attention, and the recorded observations appear to indicate that if of sound composition and manufacture and constantly submerged, it is not so sensitive, or, at any rate, not sensitive to the same extent, as when the conditions alternate between immersion in water and exposure to the atmosphere; it would seem, in fact, that where defects are noticed they generally occur between high and low-water mark, and more particularly in the neighbourhood of high-water mark and some feet above. No doubt the primary cause of the trouble lies in the penetration of moisture into the skin of the concrete, and a possible explanation why material, constantly submerged, is comparatively immune and material above low-water mark sensitive to a greater degree, may be the greater penetration of air accompanying and following absorption of moisture above low-water level and the consequent greater liability to oxidation.

The further question arises, why parts of a structure wholly above high water sometimes suffer to a greater extent than below that level. The reason suggested is the exposure of the parts to highly aerated spray, acted on by winds, with consequent deep penetration.

* No. I. appeared March 31st.

Railway Underbridges.—There are apparently only nine concrete underbridges in this country—on the Barry Railway, carrying a goods line, 1; Great Central, carrying a goods line, 4; Great Northern, carrying a passenger line, 1; carrying a goods line, 1; Great Western, carrying a passenger line, 1; carrying a goods line, 1.

Overbridges.—The information collected shows that twenty-nine reinforced concrete road bridges have been constructed over railways in this country. The spans vary from 27ft. to 76ft. and the width from 10ft. to 60ft.

Retaining Walls.—It is doubtful whether in normal circumstances any economy is to be looked for by the substitution of reinforced concrete for brick or masonry walls, either from the point of view of first expenditure, subsequent maintenance, or length of life; but there are conditions, such as weak foundations or the need to economise space, under which reinforced concrete can be used with resulting advantage.

Buildings.—Its use in buildings has been very limited and confined to a few goods sheds, goods warehouses, offices, and one granary; the returns show no examples of a station building, engine shed, or signal-box.

Sleepers.—Ten railway companies in the United Kingdom have at different times tested, both in the running lines and sidings, reinforced concrete sleepers of various designs, and seven report, in unqualified language, that they have proved unsatisfactory, one that no definite conclusions have yet been reached, and two speak of a measure of success, extended, however, over a comparatively short period. The reports generally indicate the liability of a sleeper to crush immediately under the rails, pointing to the need, therefore, of distributing over a large area the load transmitted by the base of the chair or flange rail, as the case may be. A very common feature, also reported, is the tendency of the sleeper to crack between the rails and more particularly near the centre of the sleeper, which clearly points to the necessity of leaving unpacked as long a length of the sleepers between the rails as possible.

Fencing.—The majority of railway companies in the United Kingdom are making use to some extent and on an increasing scale of reinforced concrete as a substitute for timber fence posts.

Telegraph and Signal Posts.—Telegraph posts of reinforced concrete are used to a very limited extent only; they have been experimented with by three railway companies and abandoned by two on account of their first cost and the difficulty in handling them. The experience of the third company has not been sufficient to permit of an opinion being expressed; but, apparently, so far they are considered to have given satisfaction. Reinforced concrete signal posts are being used much more generally, and, in fact, have been adopted by one company as the standard make for all signals; while another railway company anticipates that the majority of its signal posts will in future be manufactured of that material. Generally, the reports are to the effect that they are cheaper than timber in first cost and have longer life and require no painting; but their weight is considerable, frequently three times that of wood. The earlier designs were of tubular pattern and were not found to be satisfactory, largely on account of their liability to accidental damage in transit. Probably the most successful design so far is that known as the Marriott type. It is claimed that this system permits of considerable reduction in weight, the comparison with wood being given as in the proportion of two to one.

The report is accompanied by sixty-four illustrations.

In this section mechanical engineering questions are taken. Subject V. is concerned with:—

The Economic Production and Use of Steam in Locomotives.

Mr. G. J. Churchward, the late chief mechanical engineer, Great Western Railway, is the reporter for countries using the English language, and his report, dated July, 1914, together with a very brief addendum, dated July, 1921, appeared in the Bulletin for October, 1921. The problems dealt with are:—Economic production and use of steam; different systems; results obtained by superheating the steam, compounding, heating the feed water; special devices; water-tube boilers, &c.

Number of Superheater Engines.—In 1910 there were 29 superheater engines on the Great Western, 27 on the Lancashire and Yorkshire, 5 on the Caledonian, and 15 on the London, Brighton and South Coast. In July, 1921, there were 1472 on the Great Western and 170 on order, 613 on the London and North-Western and 111 on order, 257 (9 compound) on the Midland and 111 (6 compound) on order, 178 on the Great Eastern and 19 on order, 373 (2 compound) on the Great Central and 50 on order, 249 on the Lancashire and Yorkshire and 39 on order, 103 on the Caledonian and 14 on order, 50 on the London, Brighton and South Coast and 5 on order, 86 on the London and South-Western and 31 on order, 57 on the South-Eastern and Chatham and 24 on order.

In India in 1914 there were 25 and 116 on order. There, native labour only is available and coal is cheap, and the intention as to superheating all locomotives in future is not definitely expressed, as it is considered that the extra cost of equipment and maintenance

will probably not be met by the economy produced.

Saving in Coal.—The coal saved by superheating is generally reported for express service as being in the neighbourhood of 25 per cent. on test, but the actual saving on the coal bill is considerably less than that. This saving averaged for the three years ended 1914 for all the superheater locomotives on the Great Western is 12½ per cent. No appreciable difference is generally found in the cost of upkeep of superheater as compared with non-superheater locomotives. It probably is a trifle higher in the former case owing to the necessity of keeping the elements clean and quite free from cinders and ash, and the Lancashire and Yorkshire Railway reports the cost as being 6.1 per cent. higher.

Dampers.—Mr. Churchward said in 1914 that dampers for regulating the quantity of gases were usually employed, but that they were being discarded by some administrations with the object of keeping up a higher average degree of superheat, especially with regard to superheater engines employed on services which necessitate frequent stops. The Great Central Company uses a draught retarder, which discharges a jet of steam from the smoke-box end and neutralises the effect of the blower in drawing hot gases over the superheater tubes. The addendum, dated 1921, says, however, that dampers have been discarded by most administrations, as it is found that no appreciable difference is experienced in the wear of the superheater units owing to gases passing when steam is shut off. Pyrometers are not generally reliable and require calibration after use, when special accuracy is desired.

Piston Valves.—Piston valves are a necessity on all modern locomotives, but superheaters are being successfully employed on locomotives of older design with flat balanced valves. Greater wear is experienced on the valve faces and steam chest covers, but it may be neutralised to a large extent by effective lubrication and examination. Experience is showing that the piston valve of ordinary design with spring rings may be, and is, used equally as well on superheater as on non-superheater engines, the wear on the rings being probably a little more in the former case, but with effective lubrication it is almost negligible. Deposit on piston valves is generally experienced; it is usually insoluble in petrol. Analysis shows it to be principally carbon, partially derived from smoke-box ash drawn down the blast pipe, and partially from burnt oil. It may be obviated by insisting on drivers "drifting" with a small jet of steam on. This trouble still (1921) exists.

Feed-water Heating.—The use of the exhaust injector is extending, although it is by no means general. It presents a convenient method of utilising some of the waste heat of the exhaust steam from the blast pipe. The feed is delivered at about 280 deg. Fah. The Weir feed heating system is being tried experimentally by several administrations. The advantages of hot feed where waste heat can be utilised are worth obtaining. The Great Western system has resulted in about 8 per cent. economy of fuel and very considerable improvement in the life and upkeep of the boiler. Internal feed pipes, when used, become choked by deposit. This trouble is obviated by the top feed system adopted on the Great Western Railway. The feed is delivered at the top of the boiler into internal troughs arranged on the longitudinal centre line and falls in their laminæ through the steam to the water line. The troughs are removed and cleaned periodically, and it is found that deposit takes place about half in the trough and half in the boiler, and, being of a soft nature, it is readily washed out by the ordinary methods.

Modern practice points to the desirability of treating water in softening plants before being taken by the engine, in preference to using chemicals in the boiler itself. Hot water plants for heating water for feed and washing out purposes are installed by many administrations at terminal stations.

Experience in other Countries.—The report of M. Lacoin, reproduced in the September, 1921, Bulletin, contains some interesting information, from which we extract the following notes.

In 1910 the administrations reporting had 782 locomotives fitted with the Schmidt superheater, 2 with the Mestre, 17 with the Clench, and 14 with the Pielock. In 1914 these figures were 3780, 39, 17, and 15 respectively. From 1910 onwards superheating has been completely adopted for express passenger trains. For goods services one administration only hesitated to try it, but decided to do so at the beginning of 1914. It may be said, therefore, that at the present time Europe has, in an absolutely general way, adopted superheating for all its locomotives. Since 1914 the administrations referred to have in many cases replaced the Schmidt superheater by the Robinson and the Locomotive Superheater Company types. The French Eastern has also put into service new types of the Mestre superheater.

Types of Locomotives.—The principal tendencies are as follows:—(*a*) The arrangement with four cylinders and simple expansion, which was much appreciated in 1910, has developed very little, or at least only with a small number of administrations. The Belgian State and the Italian State Railways, by which it had been largely used, abandoned it in their post-war orders. The Paris-Lyons-Mediterranean and the French State Railways, which had also tried this arrangement, gave it up; (*b*) the arrangement with two cylinders and simple expansion has gradually taken the place during and since the war of the four-cylinder compound arrangement. It is in this form that superheating is progressively eliminating compounding. Two-cylinder locomotives with simple expansion are without complication, easy to maintain, and do not require a highly skilled staff. On the other hand, it might be thought they do not make nearly as good a use of the steam as compound locomotives with four cylinders and superheat. In reality, this theoretical advantage of the superheated compounds is not certain; the increase of internal resistance, due to the use of four cylinders, and the loss of tightness, due to the multiplicity of parts, appear to balance the economy that should result from compounding, if not altogether, at least so much the more as the power transmitted is less. To-day in Europe two-cylinder arrangements with simple expansion and superheat may be found even applied to the most powerful engines. The standardised types of locomotives of the French railways (State, Paris-Orleans, Midi, Paris-Lyons-Mediterranean) are simple expansion. Very powerful four-cylinder locomotives have, in fact, serious inherent inconveniences. It is difficult to give to their moving parts the necessary dimensions in order to avoid overheating and rapid wear; ruptures of crank axles are frequent, and in certain cases caused an increase of 20 per cent. in the cost of current upkeep. Nevertheless, the opinions of the European lines appear to be still sharply divided. The Swedish State, Belgian State, Norwegian State, Swiss Federal Railways, North of Spain, the French State, and the Paris-Lyons-Mediterranean have continued to order a portion of their stock with four cylinders and superheat, believing that this type is the most economical. On the other hand, the Danish State, the Midi, and Paris-Orleans Railways in France have never ordered four-cylinder compound locomotives, and apparently have no intention of ordering any in the future.

Advantages of Superheating.—The addition of a superheater, the weight of which does not exceed 3 per cent. of the engine, allows the power of the latter to be increased from 10 to 20 per cent. Thus a locomotive hauling express trains of a maximum weight of 300 tons could, after the addition of a superheater, accept weights of 350 tons. This increase of power enables it to deal with a much larger traffic without resorting to doubling the trains or having to design a new type of locomotive, the introduction of which might necessitate alterations to installations and renewing lines. The economy obtained in coal consumption is, on its side, quite appreciable, and appears to vary in general between 10 and 15 per cent. Against these advantages the increase of upkeep costs and lubrication should be taken into account. This increase is quite noticeable, but all the administrations consider it to be relatively small and representing only a fraction of the gain obtained.

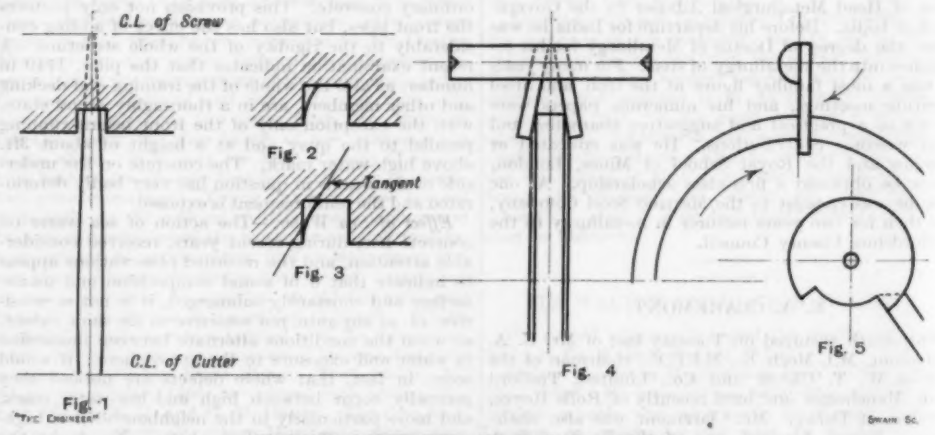
Institution of Mechanical Engineers.

THE MILLING OF SCREW THREADS.

An extra meeting of the Institution of Mechanical Engineers was held at Storey's-gate on Friday, March 31st, to discuss a paper by Dr. H. H. Jeffcott on "The Milling of Screws and other Problems in the Theory of Screw Threads." The president, Dr. Hele-Shaw, took the chair, and, in inviting Dr. Jeffcott to present his paper, welcomed him as the new secretary of the Institution of Civil Engineers.

Dr. Jeffcott did not attempt to read his paper, which is of a highly mathematical nature, but gave rather an outline of its history. It was not, he said, originally intended to take the form of a paper to be read and discussed, as it was the outcome of some theoretical investigations prompted during the war and only pretended to put those theories on record. He then went on to point out that there were three methods of producing screw threads: (1) by means of a single point tool in the lathe, (2) by taps and dies, (3) by milling, with, as a development of milling, hobbing. The cutting edge of the tool used for forming a thread in an ordinary lathe has the exact form of the axial plane section of the screw being generated. In a thread milling cutter it cannot be made of the same form, for if it were the cutting edge would foul the helix on one side or the other above or below the axial plane. This fouling is not obviated by setting the cutter axis at an inclination to the axis of the work. Thread milling cutters are at present produced by a process of trial and error. A correct screw of the required size is carefully cut in a lathe. The cutter blank is then turned and its outer boundary altered until its contour exactly fits into the gauge screw, when the axes of the cutter and screw are set at the intended degree of inclination. A template is thereafter made from the dummy cutter for use subsequently when the real cutters are being made. The process is tedious, difficult and open to inaccuracies. To place the matter on a firmer basis the author investigated mathematically the correct form which the cutting edge of thread milling cutters should have, so that the outline might be plotted on paper on a large scale and the template be verified with accuracy directly against it by the method of optical projection. Dealing with triangular threads, the author gave mathematical expressions for the cutter profile, both for the cutter and work axes parallel and inclined. The expressions arrived at are very complicated, particularly in the latter case. The corresponding expressions for square threads were deduced in each case. The paper concluded with notes on the shadow thrown by a screw thread in light radiating from a point, on the effective diameter of a screw as measured by means of three spheres instead of the usual cylindrical needles, and on the best size of cylinders to adopt for the measurement of effective diameters.

Mr. William Taylor, who opened the discussion, prefaced his comments by saying that the paper seemed to him to indicate an awakening on the part of technical instructors, to the necessity for giving more prominence to workshop practice in the training of engineers, and that he looked forward to the time when the old *régime* of 95 per cent. theory and 5 per cent. practice would give way to 5 per cent. theory and 95 per cent. practice. He said that as long as thirty years ago he had tried milling screw threads in an attempt to make accurate, interchangeable screws for optical work. It was impossible at that time to buy accurately formed chasers, and it was, of course, necessary to make the screws to close limits, as they were so fine that force could not be used in screwing them home. There was, he had found, a considerable difference in the effective diameters of screws according to the method of forming and the material from which they were made. Thus in screws made, some of cast brass and some of wrought brass, there was a difference of five ten-thousandths of an inch in diameter. It was natural that the thread should be more nearly accurate, the thinner the chip was in cutting it out, and in this respect milling was specially favourable, as the shape was formed where each of the teeth of the cutter emerged from the cut, and where, consequently, the thickness of the chip was reduced to a minimum. On the other hand, however, a thin chip was a disadvantage with an ordinary cutting tool, as it blunted the edge much more quickly than a deeper cut. Mr. Taylor then went on to discuss the author's equations referring to a square-threaded screw, and said that he had asked men in his shops and in the drawing-office if it



DIAGRAMS ILLUSTRATING MR. TAYLOR'S REMARKS

was possible to mill a square thread, as Dr. Jeffcott suggested, with the axes of the cutter and screw parallel. They all agreed that it was impossible. The only circumstances in which, so far as he could see, it would be possible so to cut such a thread would be when the screw had zero pitch—a plain groove. In the case of the other extreme, with infinite pitch, the operation was obviously impossible, and he could not see why any of the intervening conditions would be more favourable. In support of this contention Mr. Taylor exhibited a diagram, of which we give a sketch in Fig. 1, that he had had plotted from

the author's formulæ, and said that the form of thread produced by the cutter would take the shape roughly shown in Fig. 2. To emphasise this fact he pointed out that if an attempt were made to produce a cutter by the usual method of trial and error, described above, the shape of the cutter would be entirely determined by the interference of the outside corners of the thread, with the result that it would not touch the radial surfaces of the thread at all. Which brought him to the conclusion that Dr. Jeffcott's equation did not define the shape of cutter for forming a square threaded screw, but rather that of one which would not foul with such a screw. In fact, a mere saw would produce the same result as the author's cutter. It appeared possible, nevertheless, to mill an angular thread with a cutter, the axis of which lay parallel with the work, and the limiting angle of such a thread was given by the tangent to the curve shown in Fig. 3.

Mr. Taylor then went on to point out the difficulties and errors which might creep in if the author's scheme of plotting the form of cutters were carried out. The right way, according to his ideas, of generating the cutter form was to produce it by mechanical means, and in explanation of his ideas he showed the diagrams sketched in Figs. 4 and 5. As shown in Fig. 4, there would be two cutters, mounted on an arbor to represent the sides of the thread which it is desired to cut. This arbor would be given an oscillating movement and a translation axially such that the cutters would move along a path corresponding to the screw thread. A blank disc would be rotated between these two cutters and would be shaved away as shown. Such a scheme is, of course, practically a counterpart of the usual process of fitting a dummy cutter to a standard screw, except in that the screw is given cutting edges and made to do the fitting itself. The disc produced by Mr. Taylor's cutters would be cut away as shown in Fig. 5, and used in a shaping or planing machine to form a tool to go into a backing-off lathe for the machining of the final milling cutter, which would produce a thread of the form settled by the arrangement of the cutters shown in Fig. 4. Such a scheme would, he thought, be greatly superior to the Whitworth process, which debased the accuracy of the thread by degrees through a large number of stages. Thus, starting from the original standard thread, there were made first a template, to which a tool was ground up; that tool was used to machine a hob which formed a chaser. Then taps were made with the chaser and finally dies were cut with the taps.

Mr. L. M. Burt confined his remarks chiefly to the production of screw threads by means of the Richards thread milling machine, which, he said, was really a hobbing machine with no axial movement. In view of the fact that this machine was fully described in THE ENGINEER of October 3rd, 1919, in the series of articles on "British Thread Milling Machinery," it is not necessary here to reiterate the description which Mr. Burt gave; but it may be just as well to point out that if two similar screws are meshed together and are rotated in opposite directions they do not move endways relatively to one another. Thus by making one of the screws into a cutter and rotating it in contact with an oppositely rotating blank a thread will be cut which is a counterpart of the thread of the cutter. The objection to the scheme in such a crude form is that each tooth of the cutter makes a little arc-shaped cut which would prevent the production of a smooth surface. Mr. Richards thus embodied a creeping feed device in his machine which smooths out these irregularities. Later on in the evening, and with reference to the remarks of another speaker, Mr. Burt pointed out that the marks made by the cutter teeth are not really hollow gashes below the surface of the thread, but are wavy bumps. He showed a number of slides illustrating Richards' machines and some shadowgraphs to demonstrate the accuracy of milled threads as compared with those produced by the usual means in the shops. Mr. Burt commended Mr. Taylor's suggestions as to the mechanical generation of form cutters, and said that, in his opinion, it was much easier to work out such problems in the shops than to wrestle with elaborate formulæ for their solution.

Mr. Sears, of the N.P.L., said the explanation of the conflict of theory and practice represented by Dr. Jeffcott's formulæ for a square thread and Mr. Taylor's assertions was, he thought, to be found in the fact that if the theoretical cutter were extended to the limit, as shown by the dotted lines in Fig. 1, a square-sided thread would be produced, but the root would, of course, be cut entirely away. Mr. Sears also pointed out that the creeping feed adopted in the Richards screw miller must inevitably distort the shape of the thread a little as the creep moves the cutting edges, not only circumferentially, but axially also as compared with the work piece. He then went on to discuss the shadow of a thread as used in the optical method of comparing screws, and claimed that what was really produced on the screen was a focussed image of the screw in a diametral plane. This fact was, he said, explained by the practical impossibility of making a truly parallel beam of light with a condenser. If the beam were really parallel the interference caused by the helical shape of the threads would prevent such an image being obtained; but in practice some of the rays of light must be slightly out of line, and these, by escaping the projections, produce an image of the obscured parts of the thread.

Dr. Jeffcott replied briefly to the discussion and pointed out, in connection with Mr. Taylor's remarks, that although he had worked out the formulæ for a square thread, as being a special form of angular thread, he had stated in the paper that it was impossible in practice to mill a square thread in the manner mentioned.

Power House Extensions at Stoke-on-Trent.

THE electricity supply department of the County Borough of Stoke-on-Trent includes the pre-federation generating stations in Burslem, Hanley and Stoke-upon-Trent; conversion stations; and the central power-house in Park-road, Hanley. Mains also extend from Burslem to Wolstanton and Tunstall, from Stoke and Longton into portions of Fenton, and from the central power-house into Newcastle-under-Lyme and Milton. On March 31st, 1910, the Pottery towns were federated, whilst on September 1st of the same year the whole of the electricity supply came under common management. In January, 1911, instructions were issued by the Electricity Committee for a scheme to be prepared to meet further requirements, as it was evident that the existing system could not be extended by the addition of plant of the original type in each of the existing works. In his evidence before the House of Commons Committee in 1908, Sir John Snell said that a new system would have to be provided, and after visits had been paid to Manchester, Liverpool, Birmingham and several London stations, it was decided to carry out extensions on the existing Park-road site at Hanley. The plant erected on this site consisted of two 1500 three-phase turbo-generator sets, three Stirling boilers, a cooling tower, and the necessary auxiliaries.

The central power-house was opened on April 10th, 1913, and at first the existing direct-current plants at Burslem, Longton, and Stoke, and the single-phase plant at Hanley were used when it was considered economical to run them, and the supply was supplemented by a bulk supply from the new power plant, the three-phase current being converted into direct current by means of rotary converters at Burslem and Longton, and motor converters at Stoke, and into single-phase 100-cycle current by frequency changers at Hanley. During heavy loads, the local stations were run in addition to the bulk supply, whilst during times of lighter loads, such as the nights and week-ends, the entire supply was taken in bulk from the Park-road power-house turbines. When the war broke out, however, the new system was running continuously for twenty-four hours each day, and the Corporation was, therefore, in a position to meet the sudden call for extra power without immediately raising the price of current or without incurring a heavy loss.

In the winter of 1915 the load had reached 4240 kilowatts, whereas at the time of the federation it was only 2631 kilowatts, and once again the old reciprocating sets had to be put into service to meet the peak loads. The engineer, therefore, recommended that a new 3000-kilowatt set and two boilers should be added to the existing turbine plant at a cost of £33,000. The 3000-kilowatt turbine was put into service on March 13th, 1919. It had previously been decided, however, on the recommendation of Sir John Snell and the Corporation's engineer, that the turbine power-house should be further extended by lengthening the engine-room to accommodate a further 3000-kilowatt set and by providing larger boilers and doubling the capacity of the cooling towers. The decision to extend the station by adding this 3000-kilowatt set, three boilers, and two additional cooling towers, at a cost of £102,000, was made by the Council during October, 1918, and the work has now been completed.

This latest 3000-kilowatt set, which was officially put into service on March 30th, consists of a three-phase 5½-period 6000/6600-volt electric generator coupled to a turbine with a surface condenser, the complete equipment together with the switchgear having been built and erected by the Metropolitan-Vickers Electrical Company to the specifications of the Borough electrical engineer, Mr. C. H. Yeaman. To all intents and purposes the new set is a duplicate of the third set which was installed in 1919. The turbine is a Rateau high-pressure impulse machine fitted with the makers' feed-water heater, which has already been described in our columns. The tubes of the heater are exposed to steam at a pressure which corresponds to a vacuum of about 20in., and also to the leakage steam from the turbine glands and other sources. The feed water is circulated through this heater by the main condenser extraction pump, and is heated to a temperature of approximately 150 deg. The set is designed to operate at a pressure of 170 lb. per square inch, with a superheat of 200 deg. Fah., and a circulating water temperature of 80 deg. Fah.

The Metropolitan-Vickers Leblanc surface condensers for the 3000-kilowatt sets installed are each provided with Mather and Platt circulating pumps, which are driven by 110 horse-power motors, running at 1000 revolutions per minute, and valves are provided so that the pump belonging to No. 4 set can feed its own condenser, whilst the No. 3 pump is feeding into a ring main and also supplying the condensers of Nos. 1 and 2 turbines. The main air and condensate extraction equipment consists of a Leblanc rotary valveless dry air pump coupled to a centrifugal condensate extraction pump, the two being driven by a 28 horse-power motor running at 1500 revolutions per minute.

A duplicate air and water extraction equipment comprising a steam-operated air ejector and another centrifugal condensate extraction pump, driven by an 8 horse-power motor, has also been installed, the pipe connections being arranged in such a manner that the ejector can either be used simultaneously with the air pump to assist in starting up, or independently, whilst the separate motor-driven extraction pump, in conjunction with the ejector, can form a complete stand-by. The discharges of the two condensate extraction pumps are run into a common main and then through the feed-water heater to the hot well, or directly into the hot well, the heater being provided with a by-pass to enable the necessary changes in the pipe connections to be made. On the way to the hot well the condensate is measured by passing it through a Lea recorder, which has a maximum capacity of 60,000 lb. per hour.

The alternator is one of the Metropolitan-Vickers latest machines, with a self-cooling stator and rotor, the ventilating air being provided with fans at the ends of the rotor. The Stirling boilers are designed for a pressure of 200 lb. per square inch. Three of them were put down when the station was originally built. Two more of a similar type were erected when the third turbine was installed, whilst the remaining three boilers, which are nearly 50 per cent. larger than the others, form part of the station extension scheme with which we are dealing. The mechanical stokers with A type travelling grates were supplied by the Underfeed Stoker Company. There are no economisers, but the boilers are said to be capable of yielding a high efficiency. The new boilers are set singly, and each has a chimney which is 6ft. in diameter.

The cooling towers were supplied by the Davenport Engineering Company, but as the general design of this company's towers has recently been dealt with in our columns we need not say more than that those which form part of the extension to the Stoke-on-Trent power-house are capable of dealing with 400,000 gallons of water per hour, and are designed to reduce the temperature of the water from 95 deg. to 75 deg. Fah., with an atmospheric temperature of 55 deg. Fah. and 75 per cent. humidity.

The New Conveyor Company has been responsible for the extensions to the coal conveyor and elevator equipment, whilst Matthews and Yates has acted as sub-contractors for the soot and ash-handling plant. Motor-driven feed pumps have been supplied by the British Electric Plant Company, Limited, and reciprocating steam and rotary steam pumps by G. and J. Weir, Limited. Aiton and Co., Limited, were awarded the contract for the steam and circulating pipes. The D. P. Battery Company has installed a 300 ampère-hour battery, and Bruce Peebles and Co., Limited, some motor generators with boosters for converting the three-phase current into direct current, charging the battery, and for electric vehicle charging, and also for driving the fans and mechanical stokers. The extra high-tension mains which transmit the current from the power-house were supplied by Callenders Cable Company, Limited.

H.-R. WORM REDUCTION GEARING.—In our article on this gearing in last week's issue it was stated that the additional shaft connected through worm gearing to the driven shaft in the motor car starting and lighting equipment was intended for driving the magneto or speedometer. We are informed that the correct purpose for which this shaft is provided is for driving the ignition distributor in cases in which battery ignition is used.

PASTEUR CENTENARY.—In order to commemorate the centenary of the birth of Pasteur, the University and the town of Strasbourg, with the concurrence of the Pasteur Institute and the approval of the family of Pasteur, have proposed to erect a statue facing the Strasbourg University, where, as a professor, Pasteur commenced his career. The inauguration ceremonies will take place on May 1st, 1923, under the patronage of M. A. Millerand (President of the Republic), M. le Président A. Loubet, M. R. Poincaré, M. Loredu, and M. Alapetite, and will include the unveiling of the statue and the opening of an Exhibition of Hygiene and Bacteriology. This exhibition will be designed to illustrate the advances made in various branches of science as the result of Pasteur's discoveries, and at the same time a Congress of Hygiene and Bacteriology will be held for the discussion of questions relating to the prevention of disease. With the object of showing the sympathy of this country with the projects of the French Committee, a British Committee composed of the following members has been formed:—Sir Charles Sherrington, G.B.E., President of the Royal Society (chairman); Mr. A. Chaston Chapman, F.R.S., President of the Institute of Chemistry of Great Britain and Ireland (treasurer); Mr. H. E. Field, President of the Institute of Brewing; Professor Percy F. Frankland, C.B.E., F.R.S., Emeritus Professor of Chemistry, University of Birmingham; Sir John M'Fadyean, M.R.C.V.S., LL.D., Principal of the Royal Veterinary College; Professor C. J. Martin, C.M.G., F.R.S., Director of the Lister Institute; Sir W. J. Pope, K.B.E., F.R.S., Professor of Chemistry, University of Cambridge; Sir James Walker, F.R.S., President of the Chemical Society; Sir Almroth Wright, K.B.E., F.R.S., Principal of the Institute of Pathology and Research, St. Mary's Hospital. It is hoped that those who desire to contribute to the memorial will send their contributions to the general secretary and treasurer, Monsieur Th. Héring, 6, Rue des Veaux, Strasbourg; or to Mr. A. Chaston Chapman, F.R.S., the Institute of Chemistry, 30, Russell-square, London, W.C. 1. The Commissioner-General, Professor Borrel, is very anxious to be furnished with the names of manufacturers and business firms in this country to whom the exhibition might be of special interest. All who can assist are requested to communicate with Professor Borrel, 3, Rue Koeberlé, Strasbourg.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

WORKS ORGANISATION AND WAGES.

Sir,—The majority of letters appearing in your last issue are very appropriate, and should help to sway the leaders in the industrial strife in which the country is involved. A letter that appealed to me is in reference to the above-named subject.

If Britain is to hold the market for her products, the organisation of the past and present must be subject to serious consideration and modification. Animosity, which has got hold of those who are devoting their brawn, brain and capital, must be purged of all selfishness if we are to lead the way in industry and commerce; or must we resign ourselves to becoming a mass of humanity, unable to raise, on the islands and Empire we possess and inhabit, the wherewithal to sustain life, or to produce goods to enable us to purchase from others. Are we to insist on personal demands and to be forgetful of national welfare or our future.

Did we win the war in order that Germany might secure the trade of Europe and cripple the industry of other competitive countries; if not, what are we doing to prevent it. Germany, with a population of 55,000,000, has 100,000 unemployed; Britain, with a population of 47,000,000, has 2,000,000. The more the masses are made accustomed to receiving something for nothing the more parasites and proletarians the country will produce.

There must be found some practical method whereby the industrial hives can produce enough whereby to keep themselves and still maintain a strong factor of safety; and as for the drones, I would suggest the bee-keeper's method before the honey season begins; it is drastic, but it is effective. Then work can be assured for the worker of the future, that he can earn a living, and his children may know that they will also be able to earn what the unemployed advocate, at the expense of the industrial bee, "adequate maintenance," which amounted in doles for 1921 £62,500,000, and by the returns of the first three months of the current year it is going to outstrip the fore-stated figures.

Under the present system is it possible to reduce the cost of production? Men are engaged by the employment manager and allocated by him to the shops; materials are ordered and allocated to the shops by the order office; machines for carrying out the operation are purchased after collaboration between the drawing-office and the works engineer, and are fixed in the shop by the works engineer's staff, their speeds and feeds being controlled by speed and feed experts; progress of the work through the shops is governed by a planning department; heating, ventilation and lighting being looked after by the welfare department, and any disciplining of the men, which has been sadly neglected, is dealt with by the employment manager. Piecework which the workers desire, and premium bonuses or payment by results, which the employers demand, are set and controlled by timers under the direct supervision of a special department; any questions of dealing with labour or shop conditions are dealt with in conjunction with the shop committee.

Is it possible for cost of production to be reduced under such a bureaucratic system? No doubt science is good for business, but do not let us forget that science, at best, is a poor business. In times past the foreman was looked upon as being representative of the management in the shop, and the workmen looked upon him as being the visible sign of his employer. The thoughtful and sympathetic employer sees and knows there is something wrong, for in the search for workshop efficiency, human efficiency has been neglected, and that is the cause of the trouble to-day. Unless the employer looks upon the human machine as being more productive than all other high-speed tools, the demagogue will not only sow his seeds round the borders of the field, but also in the centre.

Some of the foremen are the most dangerous enemies to the increase of production, through the jealousy which exists, especially amongst those who have spent the greater part of their time in the same shop; and as for works managers, some of them know "something of everything;" but "something of everything" has become a complete impossibility. Let it be remembered that a foreman is a specialist in his own department, who is worthy of more consideration, for a "deserted garden breeds weeds without the necessity of planting them."

Eltham, April 3rd. Robert Keddie.

LOCOMOTIVE COUNTERBALANCING.

Sir,—I thank Mr. E. A. Forward for his letter. It is quite possible, of course, that the weights now in the trailing wheels of the Agenoria were not there when the engine was built in 1829, but were fitted at some subsequent period in its career of thirty years. In compiling my article, the great difficulty I had to contend with in many cases was to establish whether the drawings and photographs which I examined showed the old locomotives as originally designed or as afterwards altered. In view of the somewhat slow development of counterbalancing, there certainly seems grounds for Mr. Forward's doubts with regard to the Agenoria. This engine may have had wooden wheels in the first instance, as did the Rocket and a few others at that time; yet I believe that the majority of the early locomotives had cast iron wheels.

In the *Locomotive Magazine* for September, 1914 (vol. xx., page 238), will be found an illustration of a model of a 2–2–2 engine constructed by Kitsons in 1837 for the York and North Midland Railway. According to this reproduction, the engine had crescent-shaped balance weights in the driving wheels. From information kindly supplied me by Messrs. Kitson and Co., it appears that the model was made for a pageant in commemoration of Queen Victoria's Diamond Jubilee, and that the wheels were taken from a number which the firm had in stock. For this reason Messrs. Kitson think that the driving wheels do not correctly represent those of the original locomotive. So far as is known, "half-moon" weights did not come into use—as stated in my article—until 1861. This case shows how easily mistakes may be made.

While on this subject I should like to mention that it is often supposed that the late Mr. William Dean first adopted the Stroudley practice of putting the coupling-rod cranks on the same side as the inside cranks in 1900, in his "Atbara" class of 4–4–0's for the Great Western Railway. As a matter of fact, Mr. Dean had given it a trial twelve years previously, notably in the two broad-gauge "convertible" 2–4–0's designed and constructed by him at Swindon in 1888 and numbered 14 and 16. After the abolition of the broad gauge in 1892 these engines were entirely "reconstructed," and made their appearance in 1894 as 4–4–0's. They were then given the names of Charles Saunders and Brunel respectively. At the time of rebuilding the engines the inside and outside cranks (the cylinders being inside the frames) were arranged in the usual manner, i.e., opposite each other. These locomotives, together with two others, No. 7 Armstrong and No. 8 Gooch, form the "Armstrong" class, and are of special interest as being the only Great Western engines with coupled wheels as large as 7ft. 1½in. in diameter. No. 16 has had four different types of boilers fitted to it, the engine having been rebuilt three times. It may be said that both No. 14 and No. 16 were in reality brand new machines in 1894.

Stevenage, Herts, April 1st. F. W. Brewer.

THE H.-R. WORM REDUCING GEAR.

Sir,—I read the description of the above-named gear in your current issue with the greatest interest, and the more so since, in common with James Watt, I am a strong protagonist of worm gears for many purposes for which spur gears are commonly used. For motor cars and similar purposes no doubt a high mechanical efficiency, whilst desirable, is not necessarily the most important aim. For instance, durability and silence—especially silence—are, to my mind, much more important than 8 to 10 per cent. saving of power. But without desiring to enter on destructive criticism of this mechanism or denying in any way its obvious uses in certain fields, I should like to see the results of careful and responsible tests before being willing to accept even the lower figure claimed by the inventor, viz., 80 per cent.

Consider the facts. Take a pair of high-class double helical marine turbine gears. Now such, even with forced lubrication as an offset to the "H.-R." oil bath, and with the utmost refinements applied to design and construction to obtain the nearest possible approach to a pure rolling action between the tooth faces, do not result in an efficiency higher than some 98 per cent.

In the worm gear we have, necessarily, a pure sliding action between the faces and in the case of the worm through a length equal to the length of the thread. Thus we have both greater resistance to sliding and a greater distance of slide than with the toothed gear, where the distance of sliding is only that due to imperfect design and manufacture.

In the case of the "H.-R." gear we have three pairs of worms and wheels; therefore, if E be the efficiency of a pair and ϵ the efficiency overall, $E = \sqrt[3]{\epsilon}$. Thus for $\epsilon = 80$ per cent. we have $E = 93$ per cent.; for $\epsilon = 90$ per cent. we have $E = 96\frac{1}{2}$ per cent. Such a result can surely scarcely be expected having regard to the conditions of working even if we ignore the friction of journals.

It is obvious that, other conditions being the same, the smaller the worm diameter the higher the efficiency; but this condition is directly against a condition of large surface carrying the load on the worm and teeth and militates against perfect lubrication by a thin lubricant, by which alone we can further reduce friction.

The claim made as to the efficiency of this gear cannot, I suggest, be upheld except by direct experimental proof, and which, I hope, you will be able to publish shortly.

Angmering, April 2nd. Geo. T. Pardoe.

CARBON MONOXIDE IN LONDON GAS.

The Public Control Committee of the London County Council has just prepared a report on the percentage of carbon monoxide in the gas as supplied in the Metropolis. It first of all quotes the recent recommendation of the Departmental Committee of the Board of Trade "that it is not necessary or desirable to prescribe any limitations of the proportion of carbon monoxide which may be supplied in gas used for domestic purposes." It then draws attention to the fact that Dr. J. S. Haldane, one of the Gas Referees, who is an advocate of limiting the proportion of carbon monoxide in gas supply, had said in evidence before the Committee that he thought that a reasonable maximum would be 20 per cent. of carbon monoxide. Finally, it gives a table in which are set out the maximum percentages of carbon monoxide contained in the gas supplied by the three principal London gas companies in the years 1912 to 1921 inclusive, and during January and February of this year. It appears that only on one occasion has Dr. Haldane's figure been exceeded, namely, by the Commercial Gas Company in 1912; though the Gas Light and Coke Company went very near it with 19.17 in 1921. In January and February of this year the Gas Light and Coke Company's percentage is given as having been 15.8, that of the Commercial Gas Company 12.5, and that of the South Metropolitan Company 7.6, the averages over the whole period of the three companies being 15.6, 15.73 and 7.55 per cent. respectively. The South Metropolitan Company's figures have been consistently and considerably lower than those of the other two during the eleven years, the maximum having been 9.6 per cent. and the minimum 6.8 per cent. With regard to the high figures, 20.8 per cent. and 19.7 per cent. of the Commercial Gas Company and the Gas Light and Coke Company respectively, it is explained that they coincided with periods of coal strikes, when, owing to the shortage of coal, the companies made more water gas than would normally be the case.

ELECTRIC LIGHTING IN FRENCH COUNTRY DISTRICTS.

Although electric lighting has been for many years usual in French villages near the Swiss border, where there is ample water power, in Northern France the paraffin lamp has held undisputed sway, except in a few larger villages boasting a gasworks. The war, however, which brought with it electric lighting in dug-outs and left the shell-torn ground littered with wires, gave a lesson to the returning inhabitants, and now the cellars of ruined houses and the flimsiest wooden huts are lit by electricity, distributed throughout the villages on overhead wires from generating stations worked for the most part by petrol engines. The villages behind the lines, however, have not profited to the same extent by modern improvements, largely owing to the cost of taking the wires across country from the nearest power station. The Ministers of Agriculture, Finance, Public Works and the Interior have now obtained M. Millerand's approval of a decree instituting an inter-Ministerial Commission for the purpose of drawing up a programme for the distribution of electric power in rural communes and for finding the financial means of carrying out the scheme. It is pointed out that not only will electric lighting render life more agreeable, but that the electric power will be invaluable in such operations as threshing, pumping water, wood sawing and for many other purposes. The problem is considered to be of such importance that comprehensive treatment is necessary, and it is on that account that the inter-Ministerial Commission has been appointed.

IRON AND STEEL INSTITUTE.

The annual meeting will be held at the Institution of Civil Engineers on Thursday and Friday, May 4th and 5th, 1922, beginning each day at 10.30 a.m.

Programme of Proceedings.

Thursday, May 4th.—10.30 a.m.: General meeting of members. Award of the Bessemer Medal to Professor Kotaro Honda. A selection of papers will be read and discussed (Nos. 4 and 9). 2.30 p.m.: Afternoon session; papers Nos. 3, 1 and 5 will be read and discussed. 7.15 p.m.: Annual dinner of the Institute in the Grand Hall of the Connaught Rooms, Great Queen-street, W.C.

Friday, May 5th.—10.30 a.m.: General meeting of members; the award of the Andrew Carnegie research scholarships for 1922 will be announced; a selection of papers will be read and discussed (Nos. 10, 11, 2). 2.30 p.m.: Afternoon session; papers Nos. 12, 6, 7, and 8 will be read and discussed.

The following is a list of the papers which it is expected will be submitted at the meeting:—

Presidential address.

(1) C. R. Austin: "Hydrogen Decarburisation of Carbon Steels, with Notes on Related Phenomena."

(2) N. T. Belaiew: "The Inner Structure of the Pearlite Grain."

(3) H. C. H. Carpenter and Miss C. F. Elam: "Effect of Oxidising Gases at Low Pressures on Heated Iron."

(4) F. Clements: "British Siemens Furnace Practice."

(5) E. W. Ehn: "Influence of Dissolved Oxides on Carburising and Hardening Qualities of Steel."

(6) A. F. Hallimond: "On Delayed Crystallisation in the Carbon Steels: the Formation of Pearlite, Troostite and Martensite."

(7) K. Honda: "On the Constitutional Diagram of the Iron-carbon System, based on recent investigations."

(8) K. Honda and T. Kikuta: "On the Stepped A1 Transformation in Carbon Steel during Rapid Cooling."

(9) D. E. Roberts: "Notes on Blast-furnace Filling."

(10) D. Selby-Bigge: "Recent Developments in Power Production."

(11) A. Westgren and G. Phragmen: "X-ray Studies on the Crystal Structure of Steel."

(12) J. H. Whiteley: "Formation of Globular Pearlite."

(13) N. Yamada: "On the Heat of Transformation of Austenite to Martensite, and of Martensite to Pearlite."

Autumn Meeting.—The autumn meeting of the Institute will be held in London on Tuesday, Wednesday and Thursday, September 5th, 6th and 7th. Further particulars will be communicated to members in the ordinary course, together with the programme of the papers to be read at the meeting.

Royal Institution.—A general meeting of the members of the Royal Institution was held on Monday afternoon, April 3rd, Sir James Reid, Bart., vice-president, in the chair. The secretary reported the death of Professor P. A. Guye, of Geneva, an honorary member of the Institution, and a resolution of condolence with the family was passed. Mr. A. J. Bryant, Dr. R. H. Cole, Mr. J. Lerman, and Mr. F. W. Stevenson were elected members.

Lock Nuts.—A new type of lock nut which has been brought out by Bicones, Limited, of 61, Eastcastle-street, London, W. 1, takes the form of a special spring washer and a recessed nut. The washer is split radially, and has a conical sleeve extending from one side, which enters the conical recess in the nut. When the nut is screwed home the conical part of the washer wedges tightly between the nut and bolt, while the spring tongues on the washer grip the work. Making the recess naturally reduces the number of threads engaging with the bolt, and while the makers say that this is not important, they make the nuts deeper to compensate for this loss, if it is so desired.

The Institution of Mining and Metallurgy.—The principal speech at the annual dinner of the Institution of Mining and Metallurgy, which was held on Wednesday evening, was that delivered by Mr. W. C. Bridgeman, Secretary for Mines, when proposing the toast of "The Institution." He told the company that although the Geddes Committee had recommended the abolition of the Mines Department, the Secretaryship of Mines was to be retained, and that the Department was to be kept going with different sections collected from other Departments of State. The budget of the Department had fallen from £700,000 two years ago to £170,000. Mr. F. W. Harbord responded in a speech in which he dwelt upon the necessity for complete and sympathetic understanding between Capital and Labour, and urged again the desirability of converting the Imperial College of Science into an Imperial University of Science. Sir John Cadman, in proposing "The Mineral Industries," mentioned that to-day Great Britain was exporting coal at practically the same proportional rate as before the war—some five to six-eighths of the amount raised.

Motor Taxation and Road Maintenance.—The chief topic of the speeches which were made at the annual luncheon of the Commercial Motor Users' Association, which was held on Wednesday at the Savoy Hotel, was the incidence of taxation on motor vehicles and the use of the money thus raised for the maintenance of roads. Mr. E. S. Shrapnell-Smith, President of the Association, took the chair. Mr. Arthur Neal, Parliamentary Secretary, Ministry of Transport, said that young as the motor road transport industry was, comparatively speaking, there were already over 300,000 vehicles of the class on the road. It was his intention to ask the Committee which was dealing with the matter to adjust the tax on motor vehicles according to user, so that those who used the roads more than the average should pay more towards their upkeep, and *vice versâ*. The expenditure on road maintenance was now, he said, £50,000,000 a year, as compared with £15,000,000 in 1913. Mr. Shrapnell-Smith pointed out the difficulties of estimating the extent of the use of the roads, and deprecated the idea that railways should have power to run road transport. Mr. W. G. Lobjoit and Sir W. Joynson-Hicks also spoke on the political issues involved by motor taxation. Colonel J. R. Davidson responded to the toast of "Our Guests," while the health of the chairman was proposed by Mr. H. E. Blain, hon. secretary, Institute of Transport.

Attachments for Surfacing, Boring, and Drilling Machines.

A series of attachments for increasing the general utility of their well-known high speed surfacing, boring, milling and drilling machine is now being made and introduced by H. W. Kearns and Co., Limited, Broadheath, near Manchester. The first is a vertical milling attachment—Fig. 1—consisting of a cross-slide which can be readily fixed at one end to the spindle slide of the machine, and at the other extremity to the outer support. It is attached to the spindle slide on planed surfaces on its top and bottom edges, and carries an independent vertically adjustable milling spindle slide. The milling spindle is driven by hollow-faced spiral gear wheels from a horizontal shaft, which in turn is driven by spur gearing mounted on the facing slide of the machine. The detachable cross slide is raised and lowered by power, and all feeds are obtained by the longitudinal and transverse movements of the work table. The attachment is provided with an eye-bolt to enable it to be slung from an overhead crane.

The flange drilling attachment shown in Fig. 2 will, it is claimed, be found particularly useful by pipe founders, makers of pumps, and all engineers who have a number of holes to drill in flanges after they have been faced. The device is operated by the travelling spindle with which the machines are fitted. This spindle can be caused to revolve either independently of or simultaneously with the facing chuck. The drilling attachment is bolted in a convenient position on the facing slide, which is held stationary when drilling operations are in progress by the worm wheel dividing mechanism shown on the back edge of the facing chuck. The travelling spindle carries a bevel wheel which transmits motion to a shaft placed radially to the spindle. This shaft drives the drilling attachment, which is fitted with independent feed mechanism. The drilling attachment is also provided with accommodation for a facing tool. A steel rule attached to the edge of the slide enables the drill centre to be quickly set to the desired radius. Hand adjustment is provided for the drill spindle for use when holes have to be faced on the rear side. Accuracy of dividing for flange work is ensured by the worm wheel, which has 120 teeth. When it is required to return to facing operations, the attachment is removed and the worm disengaged from the worm wheel.

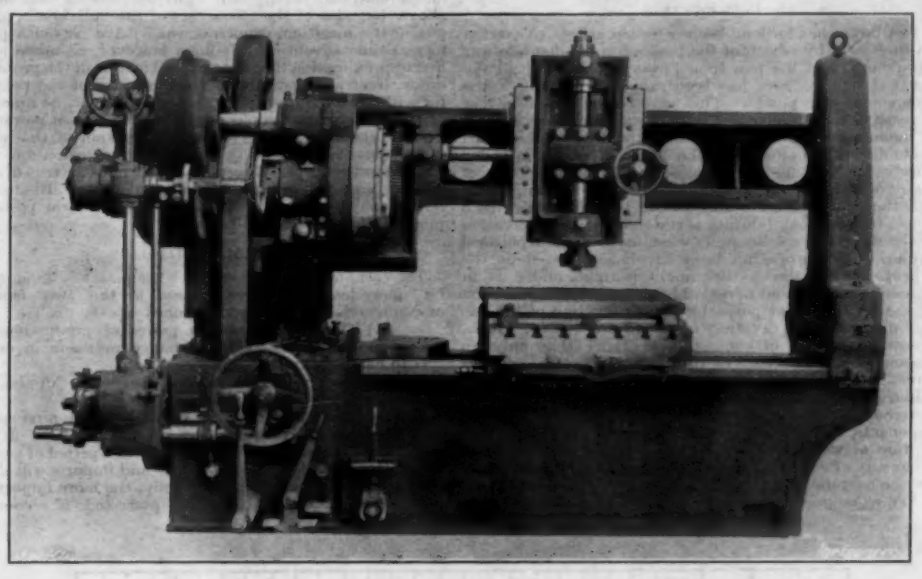


FIG. 1—VERTICAL MILLING ATTACHMENT ON KEARNS MACHINE

stantial base, are detachable, and can be supplied in various lengths.

The attachments shown in Figs. 3 and 5 are dial traverse indicators, and are the outcome of a want long felt by Messrs. Kearns in their own works for some device which will enable the spindle slide and the boring stay to be quickly and accurately set in the same horizontal plane. It will be observed that a dial indicator is placed to each of the standards. Through the medium of gearing mounted on ball bearings, the fingers on the dial are caused to revolve. The dials carry two fingers and a complete circle of the small finger measures 1ft. The circumference traversed by this finger is graduated in inches, each inch being subdivided into fifths of an inch. Each revolution of the long finger measures ½in., and the circumference of the circle being divided into 200 parts, each division on the dial represents 0.001in. The fingers are adjustable and can be set at zero for any desired datum line. The device can thus be used for measurement purposes, and with it holes can be bored at definite centres without the employment of measuring gauges. As the measurements do not depend upon any element of the machine itself they are not subject to the influence of wear. The employment of this device is, of course, by no means restricted to the machine to which it is here shown applied.

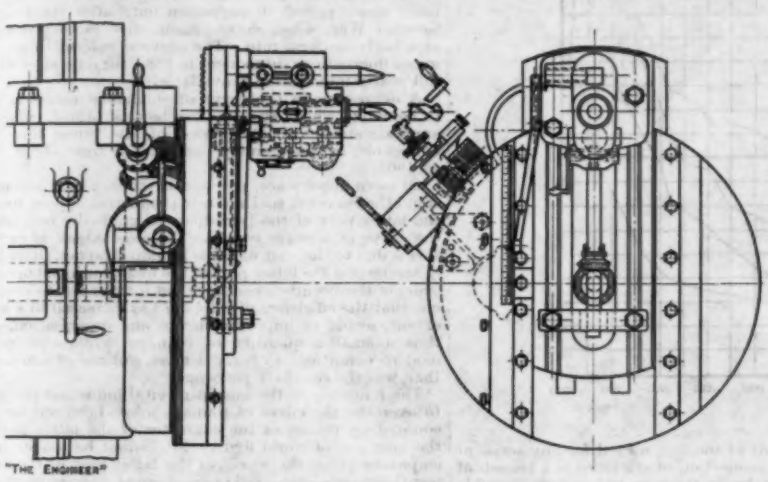


FIG. 2—FLANGE DRILLING ATTACHMENT

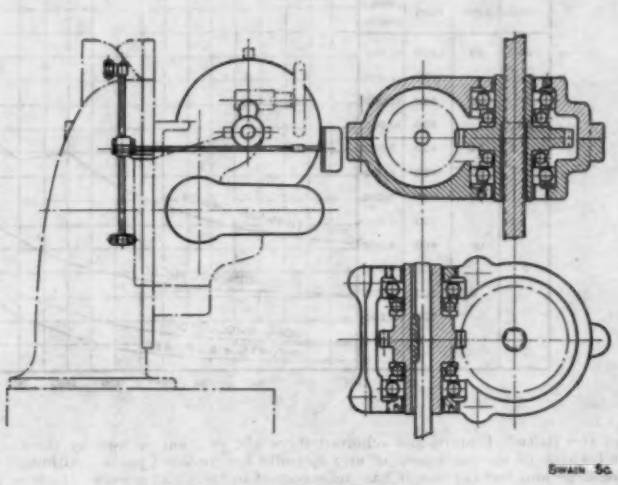


FIG. 3—DIAL TRAVERSE INDICATOR

The chuck can then be revolved, and facing operations carried out without delay.

The grinding attachment shown in Fig. 4 can be used either for internal or external operations. In the main principle the device resembles the flange drilling fitment just described, except that instead of being held stationary, the facing chuck is caused to revolve at a slow speed while the travelling spindle turns at a high speed. The grinding attachment is fitted to the facing slide of the machine as shown. The high speed required for the grinding spindle is obtained by means of two endless belts and pulleys, the maximum speed being 3000 revolutions per minute. The grinding snouts are secured to a sub-

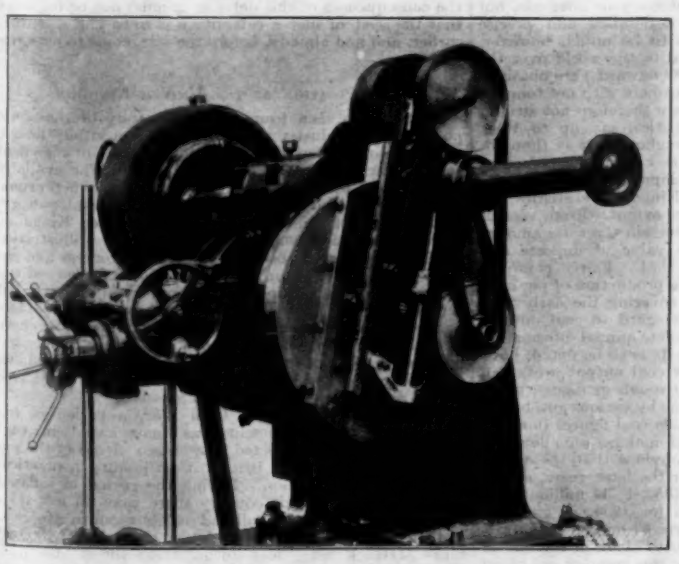


FIG. 4—GRINDING ATTACHMENT

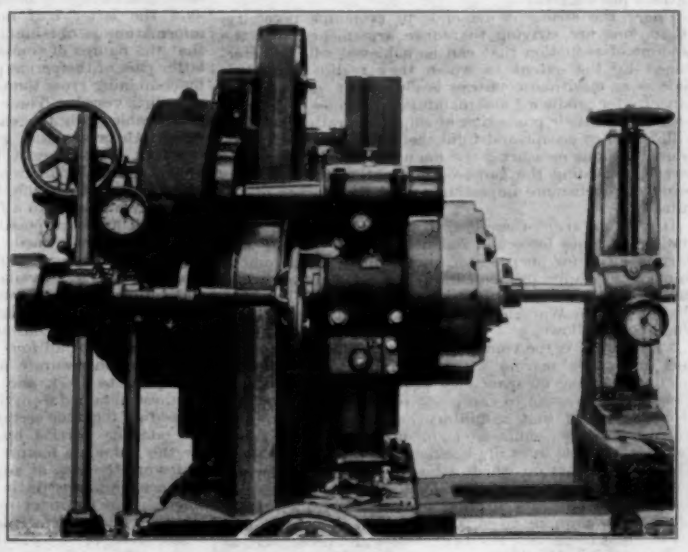


FIG. 5—DIAL TRAVERSE INDICATORS ON MACHINE

on each of the above parts. When the readings on the dials synchronise the centres of the spindle and the boring stay are in line. From the engraving—Fig. 3—it will be observed that the indicator mechanism is operated by means of a vertical non-rotating master screw attached

Merchant Shipping and World Commerce in Relation to Sea-Power.*

By SIR WESTCOTT ABELL.

Introduction.

Sea power has for long been regarded as a force exerted on the world by reason of the possession of adequate war equipment, and the maritime Power which has held the greatest fighting fleet has been said to hold with it the balance of sea power. This attitude of mind has of necessity been emphasised and exaggerated, particularly in the minds of naval architects, by the needs of the Allied fleets during the late war. The design of vessels intended purely for fighting purposes occupied the attention of many of the foremost authorities of the profession, and it will therefore perhaps be of service to the industry as a whole if mental equilibrium is restored by a consideration of the shipping problem in its wider aspects. The political evolution of Europe has been largely dominated by the "brute force" theory that might is right, and it is an obsession of the mind to regard brute force—the possession of the most efficient power for the destruction of life—as the ultimate and deciding factor in sea power. It is, indeed, a matter of common acceptance that only by reason of the existence of this superior brute force has Great Britain been able to impress her ideas of free and fair trade upon an unwilling and unready world. Such a doctrine is surely in the same category as that of the exponents of militarism, who believe in their own conception of world civilisation, and argue that there is no other way of achieving the advancement of the world than by the exercise of force.

Far from this, it would seem from all points of view that the British Empire has achieved its world position not because of the possession of any splendid instrument of destruction, but because it has endeavoured to fulfil its duties and obligations wherever the British flag has flown. This conclusion is confirmed by an elementary examination of the enormous force that would have been necessary to have kept in subjection under unacceptable customs and laws a dominion which enormously exceeded, in extent and population, that of these islands—the task would have been impossible with fleets many times bigger than any ever possessed by the whole of the maritime nations put together.

Under the stringent demands of economic necessity, all nations are striving to reduce armaments, and the amount of reduction that can be achieved will be determined by the extent to which they realise that their success as maritime countries is dependent, not on their capacity for producing and maintaining engines of destruction, nor on their possession of ships, but rather on their willingness to accept and fulfil their duty to their neighbours, without measuring the financial benefits that may accrue, regarding the game of international relations as being of much more importance than the players of the game.

If it be an error, therefore, to think that sea power is cradled in brute force and nurtured by the gods of war, it is essential for purposes of discussion to endeavour to frame a more appropriate definition, and the author would submit the one given by him in a lecture on "The Merchant Navy in Wartime," delivered in Glasgow in 1916, which is as follows:—

"Sea power is the combination of a healthy commerce and mercantile marine with the military navy which ensures by force of arms such protection as will enable the unarmed vessels to carry out their proper functions. It may be said that a military navy springs naturally from a healthy commerce; in fact, in olden times, merchant vessels were the backbone of the fighting fleet. The main factors on which a healthy commerce depend are:—(1) A power of production involving a necessity to exchange products in order to carry on trade; (2) a provision of shipping to carry products in exchange; and (3) colonies to provide points of shelter and protection, as well as to enlarge facilities of exchange. It is thus apparent that sea power is mainly dependent on natural conditions, and the nation which possesses the natural conditions to the fullest extent, and has the capacity to use them to the greatest advantage, will, of necessity, enjoy the fruits of sea power. The natural conditions mentioned may be broadly divided into three large groups, viz.:—(1) Geographical position; (2) physical characteristics, including conformation, nature, and extent of territory, as well as number of population; and (3) character of people, involving form of government."

A complete study of the problem would require a profound analysis not only of the physical factors mentioned above, but also of the characters of the individuals composing the maritime countries which have played a part in maritime adventure. It may, however, be taken as a first approximation that the physical factors of the problem are at least as important as the character of the people, for without the opportunity and environment, no amount of personal exertion could possibly build up sea power.

It is, therefore, rather to a consideration of the main factors essential to healthy commerce that attention will be paid in this paper, observing—what must be true of any country engaged in international trade—that although a nation may be run by politicians, yet its world position must be dependent on economics.

The Basic Data.

The economic bases upon which sea power is thought to be dependent are foreshadowed in the two factors of commercial prosperity mentioned above, viz.:—

(1) The possession of a power of production involving a necessity to exchange products in order to carry on trade; and

(2) The possession of the necessary shipping to carry products in exchange.

An approximate indication of progress in production can, perhaps, be furnished by an examination of the statistics of pig iron and coal output over a period of years; an analysis of the figures of exports and imports will show the extent of commerce; and finally, the more important of the two factors, the shipping possessed, is obviously shown by the amount of tonnage owned for any series of years. Although the collection of statistics is a branch of science which is yet in its infancy, it has been possible to obtain sufficient figures of:—

(1) The amount of tonnage owned;
(2) The amount of pig iron produced;
(3) The amount of coal produced; and
(4) The value of imports, plus exports,

to indicate the general trend of world development from the year 1800 onwards. For the first part of this period estimates have only been found at ten-year intervals, but over the latter half much more detailed and precise information is obtainable. It is to be noted, however, that the figures of tonnage owned in the world over the latter part of the period (from 1886 onwards) are obtained by combining gross tonnage of steamers with net tonnage of sailing vessels. These figures are therefore not strictly comparable with the earlier statistics, say up to 1880, which are presumably gross throughout. It is thought, however, that they will furnish a fairly satisfactory indication of the progress of development.

With regard to the United Kingdom, statistics are naturally available to a far greater extent. From various sources it has been possible to ascertain the total amount of net tonnage owned, and the value of imports and exports for each year back to 1801. Fairly complete information is also available of the production of pig iron, and estimates for various years covering the early part of the period are available with regard to coal output. From the year 1854 onwards, complete annual information is obtainable for all four factors. It is to be noted, however, that no accurate figures for coal output are available prior to 1854, and that the rough estimates given are those obtained from time to time by various authorities by adding together certain available coal figures (notably the quantity carried by sea) and making an allowance for the unknown factors. It is obvious that these estimates are too low, at any rate for the later years, as, for instance, the latest estimate, in 1852, is 34 million tons, whereas the figure of production for 1854, as given in Hunt's "Mineral Statistics," is over 64 million tons.

Moreover, prior to 1854 the figures given in the official returns of imports and exports for this country are based on values fixed in the time of Charles II. and George I., and although they furnish a guide to the development of British commerce over the first half of the nineteenth century, they are not comparable with subsequent years. When the Convoy Duty was instituted in 1798, however, the actual value of the exported produce and manufactures of this country was returned. Whereas the official value was roughly two-thirds of the *ad valorem* figure at the beginning of the nineteenth century, by the year 1850 the official was nearly two and a-half times the *ad valorem* total. Prior to 1854, therefore, the "real" value of exports of United Kingdom produce and manufactures has been added to the official value of imports, and of exports of foreign and colonial merchandise, to obtain an estimate of the total value of imports plus exports, for purposes of comparison. It is to be borne in mind, however, that this estimate is liable to error as regards the official values retained therein.

It is also to be noted that in these four sets of figures for both the world and the United Kingdom no account is taken of changes in the value of currency during the period covered by the investigation. The curves of imports and exports are only pertinent in so far as they indicate the volume of commerce of the world and the United Kingdom respectively. It is obvious that the curves do not truly show the quantity of goods carried by sea, since the purchasing power of currency has varied considerably over the period under review. It will be seen later, however, that it is possible to surmount this difficulty as regards the United Kingdom, for which more detailed and precise figures are available.

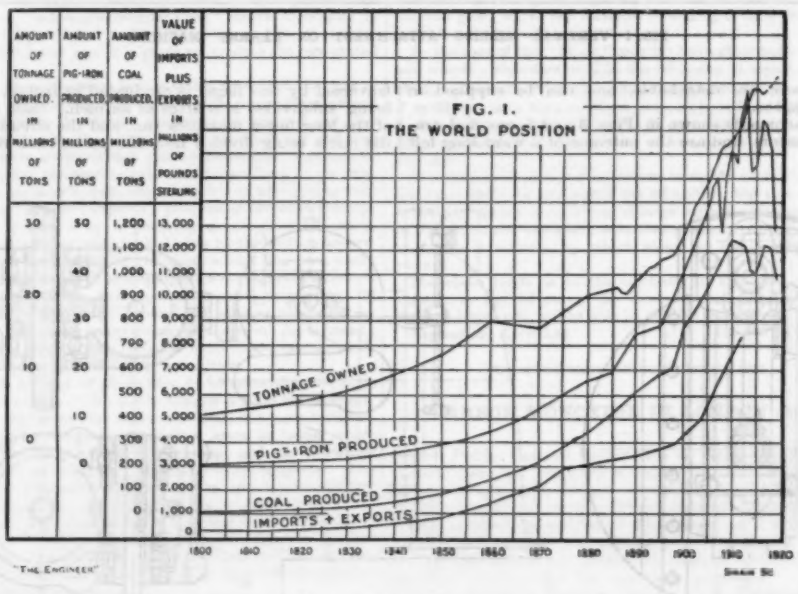


FIG. 1. THE WORLD POSITION

The world position.

As is mentioned above, the information so far collected with regard to the world as a whole is too meagre to permit of any detailed analysis. The four factors chosen, however, are given in Fig. 1, the available information being plotted on varying scales, to enable the curves to be shown on one sheet, and to facilitate comparison. It will be seen that the general trend of the curves is remarkably similar; indeed, it may be a reasonable hypothesis to assume that the curve of merchant tonnage owned is fairly indicative of the development of sea power; pig iron and coal production, though more usually quoted as guides to industrial development, are perhaps equally significant of the progress of commerce, and apart from fluctuations in the value of currency, the value of imports and exports is an index of the quantity of goods carried by sea. The general relation between the four curves is therefore not surprising, since merchant shipping surely exists for no other purpose than the carriage of sea-borne trade.

It is to be observed, however, that the tonnage owned in the world, alone of the four curves, shows a marked inflation, which apparently culminated about the time of the American Civil War. Thereafter it would appear there was a period of stagnation until after the Franco-German War, when development once more proceeded at a fairly uniform rate. The curve is subject to various minor fluctuations subsequent to 1885, the date after which full yearly information is available.

A depression in the curve of commerce values is also to be noted, which, so far as can be ascertained, coincides approximately with the period of low prices that was noticeable, in this country particularly, from about 1885 to 1905.

Of more importance, perhaps, is the fact that in general trend the curves of coal and iron production appear, during the latter part of the period, to be gradually overtaking the curve of tonnage owned. To some extent, of course, this is due to the vast increase in industrial activity which characterised the latter part of the nineteenth and opening years of the twentieth century; but it must also be pointed out that the efficiency of shipping has increased to a large extent, owing to improved design and organisation, and thus a smaller quantity of tonnage is required under modern conditions to carry a given volume of commerce than was the case fifty years ago.

The tendency of the output of vital industrial products to overtake the curve of tonnage must, however, be discounted by reason of the character of the latter part of the four sets of world figures. It cannot be too strongly emphasised that the world, in the latter part of the nineteenth century, embarked upon an era of over-production; the curves demonstrate the fact that before ever the war and its attendant frenzied activities accelerated the process, development was proceeding at an abnormal rate and an extended period of instability and depression was to be foretold, as the almost inevitable consequence. The opening phases of this collapse are only too evident; but while it is to be readily conceded that the huge production of the war period hastened the inception and exaggerated the consequences of this debacle, it must not be forgotten that the seed of such a calamity was sown half a century earlier, and had already, before the war, come to over-ripe fruition.

The Position of the United Kingdom.

It has been seen from this brief study of the world position that industry and sea power are vitally linked, and, moreover, that in general the amount of merchant tonnage owned is an index of sea power. The available figures show that developments both of production and commercial activity are reflected to a remarkable degree in the curve of tonnage owned. The United Kingdom, however, furnishes what is perhaps the finest illustration of the close relation between industrial progress and sea power.* Here, again, the amount of tonnage owned can be regarded as an index of commercial activity, but the divergences from general mutual relation are more marked than in the case of the world figures. The curve of coal production follows to a singular degree the general progress of tonnage owned, but pig iron production shows a period of marked inflation, and the curve of commerce values an almost equally large depression.

Following the American Civil War, a period of extremely rapid development was inaugurated in that country. This was reflected in a large increase of the pig iron produced in Great Britain, then holding a practical monopoly of production. During the period of inflated iron production in this country there were no less than three phases of immense railroad development in America, in 1870–73, 1880–83, and 1886–90, an aggregate of 100,000 miles of track being laid during these three "booms." The iron trade expansion required to fill the American orders for rails and other products was not, however, reflected in an increase in the production of home ores. It was not perhaps possible at the time to adapt the furnaces to reduce the various grades of ore not then in

* The Institution of Naval Architects.

* Certain curves given in the original paper are here omitted.—Ed. The E.

use; but it is to be regretted that apparently no great effort was made, after these sharp and comparatively short "booms," to effect such a conversion. Foreign ores were first used to any great extent during the 1880–83 American railway "boom," and possibly foreign competition was responsible for the fact that thereafter the amount of British ore produced per annum has declined, although the amount of pig iron produced in the country has steadily increased.

After the year 1880 the amount of ore imported increased at a fairly uniform rate, until, at the end of the period, the home production amounted to only two-thirds of the total amount available for consumption in this country. Throughout the whole of the period roughly 2 tons of ore were necessary to produce 1 ton of pig iron.

The only readily available guide to the volume of commerce of this country is that provided by the figures of the total value of imports and exports. These figures naturally take no account of fluctuations in the value of currency, and consequently the low prices prevailing, say, from 1880 onwards, are reflected in an abnormal depression of the curve of the value of commerce. It has not been possible to find any effective basis on which to calculate the quantity of goods imported and exported; nor would this necessarily be the better basis, in view of the differing values of various commodities. Obviously, however, a curve of values which is subject to the many fluctuations that affect prices is not comparable with curves which represent actual quantities of tonnage owned, or coal and iron produced. Fortunately, we have a ready means of arriving at an approximate correction for price variation, in Sauerbeck's "Index," which gives the course of average prices of general commodities in England over the majority of the period covered by this investigation, expressed as percentages of the average of the eleven years 1867–77. The inversion of these index figures yields a "correcting factor" which is thought to be of considerable value. The figures have been applied to the official values of imports and exports for the latter part of the period—1854 onwards—and the results show that the corrected curve follows very closely indeed the curve of tonnage owned, even reflecting to a remarkable degree the abnormal variations of the war period.

The foregoing comparisons indicate that the tonnage owned by a country is a distinct index of its world trade. This is, of course, particularly illustrated by the case of the United Kingdom. The world figures are complicated by overland trade, of which information is not perhaps as easily obtainable, but there is little doubt that if more complete data were available, the curves would be seen to be in remarkable agreement.

With the more detailed information obtainable in regard to the United Kingdom, it is to be observed that not only is there general agreement between the curves, but that obscure vagaries of tonnage are reflected in the movements of trade. Closer study also reveals fairly constant periodical fluctuations, and, further, that there is on the whole a fairly constant "time lag" between, say, the variations in trade and the variations in tonnage. For example, if trade improves to-day, the tonnage demand may begin to be brisk some nine months later, and the demand for new vessels will begin to grow perhaps a further nine months later yet.

The Relation Between Shipping and Shipbuilding.

Perhaps the best illustration of these periodical fluctuations is the relation between the shipping and shipbuilding of the world. The relation between shipping and shipbuilding for the United Kingdom is rather different from that of the world, for, whereas when the whole is considered, the only corrections necessary are on account of marine losses and replacements due to obsolescence, yet for the United Kingdom or any particular country, further allowance has to be made on account of shipbuilding for foreign account, and for sale to other countries of the older vessels. For example, during pre-war days some 20 per cent. of the ships built in the United Kingdom were for foreign account, while every year about 4 per cent. of the existing tonnage was sold to other flags. The figure for replacements and marine losses of British vessels was about 1½ per cent. for the years immediately preceding the war. It is therefore preferable for purposes of illustration to confine attention in the first instance to the world relation between shipping and shipbuilding. The curve of tonnage owned shows that there are periodical fluctuations about the mean value of comparatively small extent; it should be remembered, however, that the rate of change of the shipping curve is really the world's demand for shipbuilding, plus a correction for the replacement of obsolete ships and of marine losses. These replacements, under normal conditions, are fairly constant at about 2½ per cent. per annum, so that the shipbuilding curve is really, in itself, a direct measure of the fluctuations in world shipping. This is clearly demonstrated both by the integration of the shipbuilding curve and by a comparison of the tonnage launched with the net growth of world shipping. It is also to be observed that there is a fairly constant fluctuation of somewhere about a seven-year period, although the statistics available are not sufficient to enable more than broad deductions to be drawn.

This correspondence between shipping and shipbuilding is also to be found when dealing with any particular country, but here the demand is complicated by the introduction of certain new factors.

It is interesting to compare the net growth of United Kingdom tonnage with the amount of British-built tonnage added to the United Kingdom register. It will be found that there are periodical fluctuations of the same order as were observed in the case of the world fleet, but there is a considerable difference between the amount of British-built tonnage and the net increase of the United Kingdom fleet. The same result is indicated by a comparison between the tonnage registered in the United Kingdom and the integral of the curve of launchings, where there is a much bigger difference than occurred in the world comparison. This difference between the two problems is dependent on the amount of transference of existing tonnage from the United Kingdom to foreign registers. What may be called the net replacement demand arising from marine casualties and obsolescence is fairly constant throughout the period at about 200,000 tons net per annum, and the fluctuations in demand for British shipping practically depend on the manner and extent to which old tonnage is sold to foreign countries.

It is further fairly evident that it is the world demand for tonnage which causes the variation in the British shipbuilding programme, and not of necessity the natural demand from Great Britain alone. It is, however, necessary to make some small correction to the total figures on account of transfers from foreign to United Kingdom ownership, but these are almost negligible and fairly constant in amount except for the special emergency which arose during the war. The alteration in the figures caused by British vessels built abroad was practically negligible prior to the war.

Periodicity.

It is fairly evident from the above study that some general remarks on the nature and periodicity of the fluctuations which have been met with are desirable, and in this connection it may be observed that man's productivity depends on the work of his hands. In the elementary sense he tills the ground, sows seed and raises food, by the help of the rain and the sun. If there be all sun and no rain—or, equally, all rain and no sun—he cannot grow food, and cannot, therefore, exist. He is dependent on the energy he receives from the sun for his food, and for all raw material of vegetable and animal nature.

Now, in any energy system there is never at any time a unique, definite and steady state of affairs; there is always, however, a mean position of equilibrium about which physical conditions oscillate, always trying to attain a positive and unique state of equilibrium, but only reaching an exact balance for a momentary interval of time. These positions of instantaneous equilibrium should, from the information available regarding planetary oscillations about the orbits, be expected to recur at periodical intervals.

It is also known that in some respects the energy emitted by the sun varies in intensity, for it has been observed that the presence of sunspots is often accompanied by large electrical disturbances on the earth, and astronomical observations over many years have shown a certain degree of periodicity in the appearances of such disturbances.

Perhaps the most direct manifestation of the variation of energy is the wheat yield of the world, the amount of yield varying from year to year, and, of course, revealing not only bad years, but bad groups of years in contrast with good periods. This phenomenon is, of course, masked to some extent by the human element, which in prosperous times increases the acreage under cultivation, until it is overdone, and reverses the procedure in dull years.

In another direction, the variations of the tides illustrate how planetary influence affects the energy of a system, with the result that it has been found possible to separate the individual effects of the various planets, and by superposing their influences, to predict to a reasonable degree of accuracy the height of tide at a particular spot at a given time.

There are, therefore, many reasons for supposing that as regards raw material of vegetable and animal origin, the quantities available vary from time to time, and may be presumed also to vary in a periodical manner either simple or complex.

On the contrary, it may be argued that as far as mineral resources are concerned, there is no such marked fluctuation in production, and that with close regulation of business affairs there would be no periodicity at all in the variation of output. But by regarding the industrial working organisation as an energy system, and applying to it the same reasoning as has been used for the production of raw material from vegetable and animal sources, it would appear that such a system would perform periodical fluctuations about a position of equilibrium, and that the periods would to a large extent be influenced by the variations in the supplies of raw materials.

It may be taken that the amount of tonnage which the world possesses at any one time is a fairly accurate index of its trading activity, and it is also known that the variations in tonnage—*i.e.*, the demand for new ships—fluctuate in a very marked manner, and, as far as the short period over which statistics have been kept is concerned, in a fairly constant period. It is not to be inferred, however, that the periodicity is as simple as would appear from this particular example, and in general it must follow that the variations of any commodity with time will be composed of a number of factors of different magnitude and different periods.

It will further have been seen that variations in the output of a particular commodity are followed by similar fluctuations in the demand for other goods, and that there must be a fairly constant "time lag" between a development in one direction and the consequent increase of activity in other ways. For example, it will follow that an increased demand for cotton goods in the United Kingdom will mean a call for more raw cotton, and for more coal, but it will take time for such increases to be brought about, before the ships are available to bring in the raw material for the manufacturers, and the increased demand for new ships will come some time after the call for more tonnage.

It is therefore necessary to study at least three factors:—

(*a*) The periodicity and the amplitude of the fluctuations of the principal industrial manufactures;

(*b*) The "time lag" between the maximum or minimum variations of different commodities; and

(*c*) The character and nature of the mean position of equilibrium.

As regard this last point, it will perhaps serve as an illustration of the principle involved to consider the introduction into the world of a new consumable commodity which is of universal application. It may be supposed in the first instance that this article is produced in a perfect condition, but that the world is not aware of its value until a certain time has elapsed. Consequently, its rate of growth during what may be termed the period of introduction will be comparatively slow. After that time, the demand will increase at a constantly increasing rate for a certain length of time, *i.e.*, until the whole world has begun to demand the commodity in question in such quantities as it can reasonably absorb, which stage may perhaps be called the "absorption period."

From that time onwards, the rate of increase will fall off, but as the population of the world is increasing, the demand for the commodity will increase, but at a gradually decreasing rate, because in the limit the world can only ultimately support a certain number of population, and therefore, can ultimately only take a certain amount of the commodity. It will, therefore, follow that the character of the mean position of equilibrium on a time basis is divided into three portions:—

(*a*) An initial portion, in which the rate of change with time is very slow. This may perhaps be referred to as the "growth period."

(*b*) The second portion, in which the rate of change of growth is gradually increasing up to some maximum value. This may perhaps be called the "absorption period."

(*c*) The last period of growth, in which the mean position is of constantly increasing value, but is increasing at a rate of change which decreases with time.

It will be found that what is known as the curve of probabilities expresses in an approximate way these characteristics, and the mathematical expression

$$y = B e^{-\frac{c}{x}}$$

takes account of this kind of change, where y is the ordinate and x is the time abscissa, and B and c are constants to be determined by an analysis of the available statistics.

It is considered that this expression gives the general form of the mean position of equilibrium, but to obtain the positive value at any given time the periodical fluctuations already referred to—which will perhaps take the form of a Fourier's series composed of sine and cosine terms with definite phases, with the time lags appropriate to the various periodical variations—must be superposed.

In order to give some more concrete idea of the application of this principle, Fig. 2 shows an analysis of the position of the shipping of the United Kingdom for the last 120 years. The actual net tonnage registered in the United Kingdom for every year is plotted, and the fifty-six-year mean average curve has been obtained and plotted at the centre of each fifty-six year period. This actual mean curve can only be obtained between the years 1828 and 1891, but it has been exterpolated by the use of an equation similar in character to that of the curve of probabilities, and these extensions are shown as dotted lines. Further analysis indicated that there was somewhere about a nine-year periodical fluctuation, and the peaks of such fluctuations are shown by marks on the diagram. These positions were obtained by plotting the nine-year mean average curve and taking the average oscillation over any period of five years about the mean curve. In addition, there appears to be a big wave, with a period of somewhere about fifty to fifty-six years.

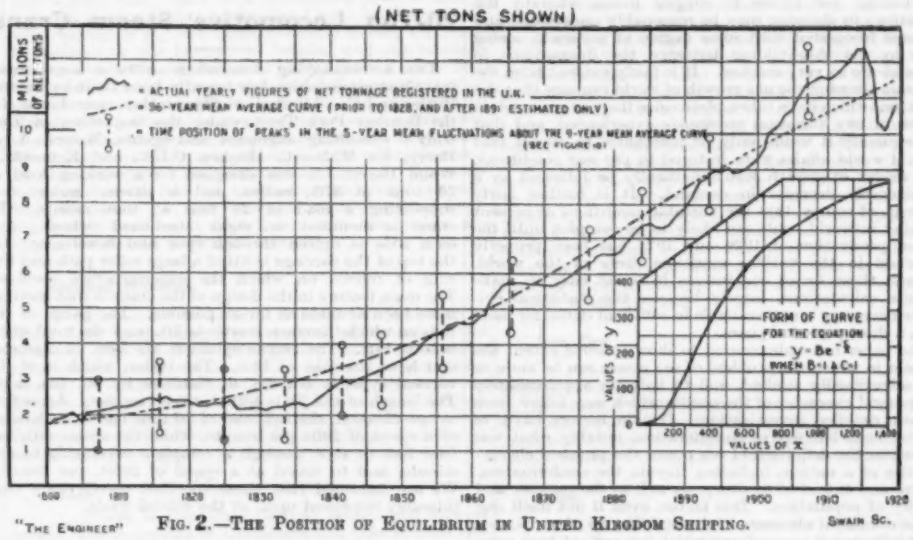

(NET TONS SHOWN)
MILLIONS OF NET TONS
= ACTUAL YEARLY FIGURES OF NET TONNAGE REGISTERED IN THE U.K.
= 56-YEAR MEAN AVERAGE CURVE (PRIOR TO 1828, AND AFTER 1891 ESTIMATED ONLY)
= TIME POSITION OF "PEAKS" IN THE 9-YEAR MEAN FLUCTUATIONS ABOUT THE 56-YEAR MEAN AVERAGE CURVE (SEE FIGURE 4)
FORM OF CURVE FOR THE EQUATION
$y = Be^{-\frac{c}{x}}$
WHEN B=1 & C=1
VALUES OF y
VALUES OF X
1800 1810 1820 1830 1840 1850 1860 1870 1880 1890 1900 1910 1920
"The Engineer"
Swain Sc.

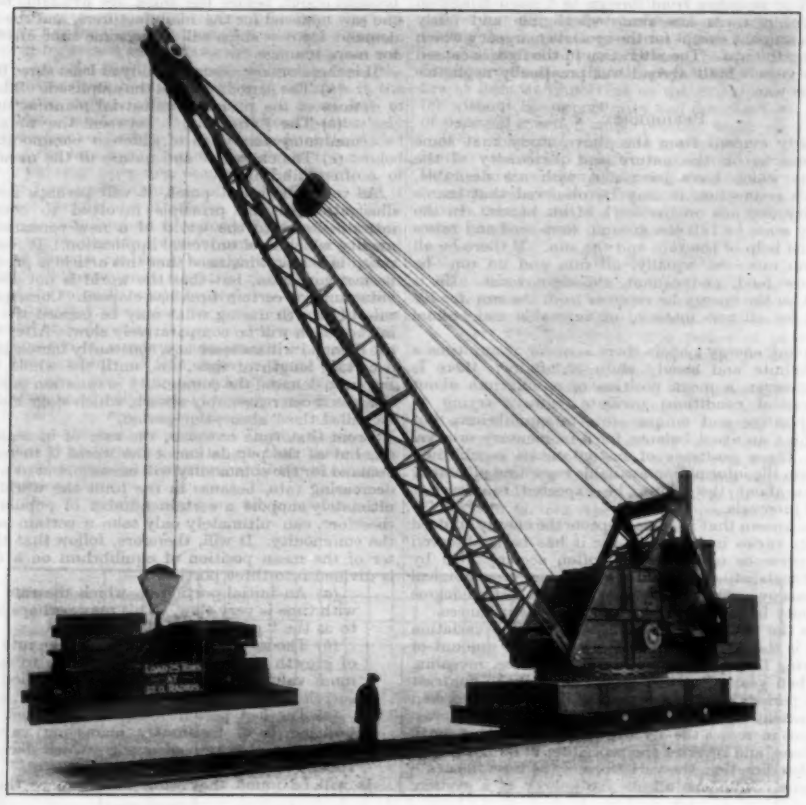
Fig. 2.—The Position of Equilibrium in United Kingdom Shipping.

Conclusions.

It is not the precise intention of the paper to draw specific

STEAM CRANE FOR BOMBAY

SAMUEL BUTLER AND CO., LIMITED, STANNINGLEY, ENGINEERS



conclusions, but rather to suggest means whereby the variations in shipping may be reasonably understood and perhaps forecasted with some degree of accuracy, seeing that in the shipbuilding industry the fluctuations in demand are so very marked. It is fairly evident from the diagram showing the net growth of world tonnage that the additions which have taken place since the war are much in excess of any variation previously experienced, and that consequently it would only be reasonable to expect that even if world affairs were restored to pre-war conditions, this excess of growth would naturally be followed by a considerable decrease in demand. It is further fairly evident, of course, that the unstable conditions at present existing in world trade are likely to be complex until the excess production of 1920 and 1921 has been properly absorbed in the various maritime fleets of the world. Beyond these broad conclusions it is not easy to make definite calculations, largely because the statistical evidence necessary is not available in sufficient detail for more than a short period of years.

The paper has endeavoured to show to some extent the manner in which the problem of sea power can be more or less scientifically studied, and to indicate approximately the general character of the results which may follow from a more detailed investigation. Certain factors have, of course, been left out of consideration, notably what was termed in the definition of sea power the physical characteristics of a nation, including therein the conformation, nature and extent of territory, as well as the number and quality of population. This factor, even if not itself one of the dominant elements in the building up of sea power, must influence it in a manner which has not yet been even approximately investigated.

It does appear, however, that sea power is influenced not nearly as much by the wielding of force as by the intelligent application of economical factors, which, in any system, must of necessity vary in a stable manner about the mean position of equilibrium.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Sir Charles Bright and Partners, consulting engineers, of 146, Bishopsgate, London, E.C. 2, inform us that the firm's telephone number has been changed from Central 256 to Bishopsgate 1120 (two lines).

Anglo-Spanish Industrial Association asks us to state that it has moved from Amberley House, 12, Norfolk-street, Strand, to Lennox House, Norfolk-street, Strand, W.C. 2. Its telephone number remains the same.

Anglo-Overseas Engineers and Merchants, Limited, informs us that it has removed from Amberley House, 12, Norfolk-street, Strand, to Lennox House, Norfolk-street, Strand, W.C. 2. Its telephone number remains the same.

Motor Headlights.—The Council of the Optical Society is arranging a programme of papers dealing with motor headlights, having reference more particularly to the optical problems involved. The question of "glare" or "dazzle" and the methods proposed for overcoming it will be considered, both from the point of view of the optician, the lamp manufacturer, and the road user. The meeting will be held at the Imperial College of Science and Technology, South Kensington, on May 11th, and anyone desiring to contribute to the discussion or to exhibit models or give experimental demonstrations is requested to communicate with the honorary secretary of the Society, Mr. F. F. S. Bryson, Glass Research Association, 50, Bedford-square, W.C. 1.

20-Ton Locomotive Steam Crane.

The accompanying illustration shows a large steam travelling crane which has recently been built by Samuel Butler and Co., Limited, of Stanningley, near Leeds, for the Bombay Port Trust under the inspection of that body's consulting engineers and agents, Messrs. A. J. Barry, Sir Walter C. Hughes, C.I.E., and Kenneth A. Wolfe Barry. It was designed for a working load of 20 tons at 37ft. radius, and is shown under test supporting a load of 25 tons at that radius. The crane is mounted on eight steel-tired wheels, and each axle is driven through spur and bevel gear. On the top of the carriage is fitted a large roller path and live ring of rollers, on which the superstructure revolves. The main feature in the design of the crane is that castings have been avoided as far as possible. The gauge of the rails on which the crane travels is 7ft., and the total wheel base is 14ft. The engine cylinders are 10in. in diameter and have a stroke of 14in. The boiler, which is of the vertical type, is 4ft. 6in. in diameter by 9ft. 6in. high. The length of the jib is 45ft. between centres. According to specification, the full load of 20 tons had to be hoisted at a speed of 20ft. per minute, while the crane with full load had to slew through a complete revolution in one minute, and to travel at a speed of 200ft. per minute. We are informed that these specified speeds were considerably improved upon at the official trials.

Retirement of Mr. Henry J. Spooner.—Mr. Henry J. Spooner, A.M. Inst. C.E., M.I. Mech. E., M.I. Auto. E., F.G.S., &c., Head of the Polytechnic School of Engineering, Regent-street, which position he has held for the past forty years, is retiring in July. During his long tenure of office over 20,000 students, many of whom are at present holding important official administrative and executive positions in all parts of the world, have been trained under him. His retirement is being made the occasion by his past and present pupils for presenting him with some tangible evidence of their appreciation. Old students who desire to contribute are asked to communicate with Mr. F. R. S. Rice at the Polytechnic, Regent-street, W. 1.

Brazilian Centenary Exhibition.—An excellent opportunity for British manufacturers and merchants to extend and open up new business in South America is offered by the Brazilian Centenary Exhibition, which is to be held at Rio de Janeiro from September 7th to December 31st next, in celebration of the centenary of Brazilian independence. Practically every country in the world will be represented at the exhibition. The British section is being organised by the Department of Overseas Trade. Realising that many British firms which could do business in Brazil cannot at present afford the sum necessary to exhibit their actual goods on the scale required, the Department has made arrangements for the display of such goods by means of models, cinema films, lantern slides and lumiere plates or coloured reproductions on glass. The cost of exhibiting at the exhibition on such lines need amount, it is said, to no more than £30 for the three months of its duration. No additional expenses need be incurred for salesmen, the Department having arranged for the presence of representatives to deal with orders and inquiries for exhibitors who desire such help. The building in which such exhibits will be displayed is being built by the British Government in the best part of the exhibition area, and at the conclusion of the exhibition will be formally presented to Brazil as a permanent token of British sympathy with Brazil and the century of independence it commemorates. On either side of the building temporary wings are being constructed to accommodate the actual goods of exhibitors. Full particulars can be obtained on application to the Department of Overseas Trade at 35, Old Queen-street, Westminster, S.W. 1.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

April Iron Trade Quarter Day.

The April quarterly meeting of the Midland iron trade was held this week in Birmingham—a week before the usual time because of the approach of the Easter holidays. In consequence of the shipbuilders' strike and of the engineering lock-out, the tone of the meeting was unsatisfactory and disappointing, and little business was done. The engineering crisis is reacting on the Midland bar iron trade, more particularly in the higher grade qualities than in the lower. Iron and steel works are not expecting to have to cease operations, but it is generally considered that the outlook is far from encouraging. Whatever the future course of the struggle between the Employers' Federation and the unions, a shock has been given to confidence which the iron and steel market will not get over for months to come. There are very few indications of attempts to force the market by quoting lower prices. Sellers are fully alive to the futility of such a policy. Iron and steel are being made at a loss, and producers are not disposed to risk further loss for the sake of the small orders which are now obtainable. Buying of all raw materials is cut down to the lowest limits. Some orders have been cancelled, and in other cases producers have been asked to withhold deliveries. The pig iron market has relapsed into a torpid condition. With the prospect of the foundries closing down, business on that side has ceased for the time being, save for a few unimportant transactions. Smelters adhere to their prices. There is talk of some blast-furnaces which have been restarted damping down. Little forge iron is coming on to the market, but it is more than enough to satisfy demand. Now that the shipbuilding strike is at its height, some orders from shipbuilders, particularly for best iron, have been cancelled, and other new business lately expected to materialise is being held back.

Local Effect of the Industrial Disputes.

Iron and steel masters in this district are not expecting to have to close down their works, even if the strike extends. As the auxiliary workers, such as fitters, roll-turners, &c., are now included in the wages board arrangements, they are likely to continue at work. Certain engineers, particularly those engaged on constructional work, are not disposed to join in the lock-out, as they consider the reduction too drastic, and their men therefore are expected to continue employed. Things are, however, drifting into a worse position in factories and workshops. With demand much below the normal, deliveries have been fairly well maintained by many manufacturers who come within the range of the lock-out, but disorganisation is becoming more apparent. Engine builders and other mechanical engineers who employ a large proportion of skilled craftsmen have, of course, suffered more severely than those in whose production systems automatic and semi-automatic machine work preponderates. Machine tool makers have been able thus far to make some sort of progress with the few orders they were engaged on when the lock-out started. This branch has been very depressed for a long time, and there is no prospect of an early revival. No serious consequences are apprehended from the delay of output. Constructional engineering yards do not appear to have been greatly affected. The position in Coventry becomes more serious every day. Business has stagnated, with output limited almost entirely to the non-federated firms. As was anticipated, the stoppage has already had the effect upon several of the largest firms of reducing working hours throughout the whole of the shops, and unemployment is increasing.

Finished Iron Trade.

At the quarterly meeting in Birmingham this week, it was generally agreed by ironmasters that the slight improvement latterly perceptible in the nut and bolt industry could not be maintained in face of the engineering crisis. Competition is slowly forcing down quotations for bars. Business could be done at £10 7s. 6d. delivered yesterday, though £10 10s. was still asked. Endeavours are being made to prevent fencing iron falling below £10 12s. 6d., but in some quarters it is held that business has passed for fair quantities at £10 10s. per ton. It is reported that Scottish mills are trying to get a foothold in the district with Crown bars, which they are willing to deliver at £11 10s., but local producers will not be undersold on those terms. Indeed, both Staffordshire and Lancashire houses have for a week past been accepting £11 10s. for Crown bars of a higher quality than those obtainable from Scotland. The galvanised sheet branch is dejected. It is stated that successful efforts have been made in some cases to break down the quotations of £16 and £16 5s. for galvanised sheets for export and domestic trade, though makers continue to assert that neither price is remunerative. Black sheets, which are picking up a little, can be bought at £11 10s. per ton. Plate shearings make £6. A new steel strip mill has been started in the Black Country this week.

Iron Trade Wages Reduction.

The Midland Wages Board has issued its ascertainment of selling prices during January and February, showing, as was expected, a substantial reduction, the effect of which will be a cut of 27½ per cent. in the wages of ironworkers from Monday last until the end of May. It is noteworthy that, whereas reductions in the Northern district have hitherto been of a more sweeping character, that area on this occasion takes 20 per cent. The disparity, of which complaint was made by local ironmasters at the recent Wages Board annual meeting, is thus reduced by 7½ per cent. But the percentage above the standard in this district is still 62½, as against 47½ in the North of England. The matter of adjustment is now in the hands of the Wages Board, on the representation of the Staffordshire masters that the payment of higher wages affects

them unfavourably in competition with the North of England, both in the home and foreign markets. Experience has shown that sliding scales vary in their operation, and adjustment becomes inevitable from time to time. The pressure upon manufacturers resulting from this cause is particularly unfortunate at the present time.

Business in Pig Iron.

Some fairly good transactions have taken place in pig iron, especially in Northampton and Derbyshire, as these districts now compete with Cleveland, selling pig iron from 5s. to 7s. 6d. lower than the Cleveland quotation. Some lots of pig iron are being sent to the North-Eastern area, and, in addition, inquiries have come from Australia and the Far East for Midland pig irons. While it has been necessary to damp down furnaces in Cleveland, those in the Midland area continue at work, although the furnaces in operation are a comparatively small proportion of the existing plant. The market for foundry pig has suffered a good deal on account of the engineering dispute, and consumers are not tempted even by the present low prices to buy. The chief reason why prices remain fairly steady is their lowness, to the point of being unprofitable. Until recently, prices declined steadily week by week, each succeeding order being placed at 2s. 6d. less than its predecessor, until now smelters declare they are working at an actual loss. Some little relief has been obtained from lower coke values. Derbyshire No. 3 foundry iron is now quoted 82s. 6d. to 85s., and forge 72s. 6d. to 75s., while Northamptonshire forge is about 70s. and foundry 80s.

Steel Outlook.

The outlook in the steel trade is uncertain, and the market is far from active. Some sellers of billets are quoting an additional 2s. 6d. on the 5s. added a fortnight ago, making the quotation £7 12s. 6d., but it does not appear that this price has been paid. Welsh billets are also dearer at £11 15s., but that is beyond the ideas of buyers on this market, who claim to do business at 5s. to 7s. 6d. less. Re-rollers have increased their selling price for bars from £9 5s. to £9 10s., following upon the higher values of billets and semi-finished material generally. There is some disappointment in steel circles that the railway authorities have postponed their revision of freight charges through the lock-out. The policy is strongly criticised, as it is believed that in any event concessions of this kind would help business revival. Another grievance strongly complained of is the heavy taxation, manufacturers confirming the statement made by Sir Ernest Hiley that large firms have to work four months of the year solely for the payment of taxes.

Birmingham War Bonus Reductions.

In the "Latest News" column last week I intimated that one of the unions concerned in the Birmingham and Wolverhampton area engineering war bonus dispute had come to terms with the employers. This week I had thought to be able to announce that an agreement had been made between the Allied Trades Employers' Association of the Engineering and National Employers' Federation and the National Union of General Workers, the Iron and Steel Trades' Federation, and the Amalgamated Society of Metal, Wire and Tube Workers, for a reduction of 16s. per week in the war bonus of 26s. 6d., the reduction to take effect in three cuts, the first on April 10th of 6s. per week, the second on May 29th of 6s., and the third on July 17th of 4s. A hitch has, however, occurred as far as the National Union of General Workers is concerned, its General Council having refused to ratify the agreement entered into by its negotiators, mainly on the ground, I understand, that the arrangement entered into does not obtain for its members immunity from the lock-out on managerial functions in the allied trades. The employers are not greatly exercised over the matter, because the union in question only speaks for a small minority of the men affected by the reduction. The incident, however, is illustrative of the difficulties and uncertainties which employers have to face through divided counsels in the trade union ranks. In this instance, they do not propose to modify their attitude. The notices intimating the reductions have been posted, and the first reduction will be made, as arranged, on April 10th.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE general position in the iron and metal markets is not greatly changed, and as a rule people are waiting to see whether or not a settlement of the various disputes can be accomplished this week. There is, of course, very little business going on here, and cannot be until the engineering works get into operation again; but it is to be feared that work is drifting away to the Continent while trade is being held up on this side. Some definite cases of ship repairing have been heard of already; but, of course, one does not always hear of these cases until some time after they have been lost to British industry. It seems almost incredible that in the present state of unemployment disputes involving the wholesale stoppage of work should be possible. Manchester is not yet sure that the proposed reduction in cotton trade wages will be effected without a stoppage, and if not a further disastrous time is in front of Manchester business.

Metals.

Of course, there can be no satisfactory demand for metals in the Manchester district at the present time. Transactions in the metal market occur from time to time, but the quantities are almost negligible. It seems a little paradoxical, but the only thing which sustains the copper market at the moment is the low price. The "bears" have little or nothing to go for, and hence they neglect a unique opportunity of raiding the market. The price of standard copper has now returned to the level obtaining at the end of February, but the whole of the rise which took place in March might be covered by about £3 per ton; so that there was evidently no serious recovery. It is now thought that the increased production of copper in America will begin to come forward for sale before there is time for a recovery in the demand; in which case easy prices may be expected to last for some time yet, even if they do not cover the whole of this year. The inference is that there is still no hurry necessary for those consumers who will need copper during the next few months. The last report of electrolytic prices in America gave about 12¼ cents per pound as the value, but at the present rate of exchange that is not greatly different from the prices current here. The demand for scrap metals is very poor, and dealers seem to be buying for stock at low prices; so that there should be an opportunity of getting a cheap supply of scrap when engineers—who have their own metal foundries—are ready to use it again. Good gun-metal scrap appears to be bought by dealers at about £37 to £38 per ton, and good yellow brass scrap at £26 to £28. There would seem to be a much wider difference than usual between the prices paid and the intrinsic value of these metals. Ordinary yellow brass could not be made from new copper and spelter at less than £50 per ton; even a 60 and 40 mixture would cost as much. In the market for tin there has been no definite change. Apparently there has been rather large selling from the East, and some apprehension has arisen lest the holders of dear tin—such as the Federated Malay States Government—may have decided at last to liquidate some of the metal in spite of former promises to the contrary. The demand for tin is, of course, very poor here, and apparently it is not much better in other parts of the country. The feeling in the lead market is rather strong at present, but probably because the supply of prompt metal is short, and as consumers have for a long time worked on a small stock the demand is usually for immediate delivery. In spelter there has been a slight improvement, but prospects are uncertain, because it is not clear yet whether or not America will come in as a seller.

Pig Iron.

The position in the foundry iron market shows very little change. One more Cleveland furnace has been put out in consequence of the diminished demand, and it seems to be thought that if the engineering dispute and the other troubles are settled this week there might be a temporary shortage in Cleveland iron until more furnaces have been re-lighted. On the other hand, the reduction by the Scottish ironmasters of their furnace price for No. 3 Scotch must check any Scottish demand for Cleveland iron, and the Lancashire ironfounder may again become a personage of importance to the Cleveland ironmaster. It is now a great many years since the furnace price of Scotch iron was so near to that of Cleveland iron. In Manchester, what buying of pig iron there is—and it is very trifling—is confined to the Derbyshire brands, and the nominal price is about 92s. 6d. delivered in Manchester. Now and then a small parcel is heard of at less, but the market price may be reckoned at 92s. 6d. Scotch iron, delivered in Manchester, is a little cheaper, but there is still a difference of about 22s. 6d. per ton between Scotch and Derbyshire No. 3, and this difference is, of course, more or less resented by the consumer. His resentment, however, is not so much against the Scottish ironmasters as against the railway companies. It has been said that Cleveland forge pig iron is firmer and dearer, but here one cannot see any indication of a revival in forge iron.

Finished Material.

Almost all business in finished iron and steel is being held up pending the expected settlement of the lock-out. Makers do not attempt to press sales and make no alteration in their prices. There is no indication of any renewal of competition from the Continent, although one notices a downward tendency in France and Belgian material. Luxembourg foundry iron, for instance, has been put down 5s.; but if it were lowered another 10s. it would still be too dear to interfere with our markets.

Scrap.

There is absolutely nothing being done here in scrap. The ironworks of Lancashire still take in local lots of heavy wrought scrap at £3. Ironfounders are not buying cast scrap, but the nominal prices quoted by dealers are not altered.

Lancashire Trade.

Although the engineering industry in this part of the country has been brought to a state approaching stagnation by the present dispute, signs are not altogether wanting that with a resumption of work an improvement in trade will come about. One of the reasons for belief in a probable improvement is the slight change for the better which has come over the cotton trade. During last month many mills in different parts of Lancashire which have been closed down for a considerable time through lack of orders have re-started, and if a satisfactory settlement of the present wages dispute in the cotton industry can be effected without causing a stoppage and the cost of production further reduced, the spinners and manufacturers will be able to secure more work, for it is generally recognised that the world's markets are bare. At present the wages of cotton operatives are generally 140 per cent. above the last pre-war rate, and notice has been given by the employers for a reduction of 75 per cent. off the 140 per cent. Another factor which will tend to improve trade is the decision of the Indian Government to reject both the recently proposed increases in the import and excise duties on Lancashire cotton goods. This decision has come as a great relief to the cotton industry and will tend to restore confidence. It is an accepted fact that the welfare or otherwise of other industries is largely dependent on our export trade in cotton goods, and when this becomes normal again engineering will commence to benefit.

Salford's Electricity Undertaking.

A special committee of the Salford Corporation has now under consideration the question of the appointment of an electrical engineer in place of Mr. J. A. Robertson, who has expressed a desire to retire. A proposal has been made that Mr. Robertson should be appointed consulting engineer at a salary of £500 per annum and travelling expenses, and the committee also recommends that Mr. Robertson should supervise the erection of the new super station which it is proposed to erect at Agecroft, and which will probably cost nearly one million pounds. A special meeting of the borough council will shortly be called to consider the recommendations of the special committee.

Turbine Gearing.

A short paper on the above-named subject was read before the Liverpool Engineering Society on Wednesday last by Mr. S. B. Freeman. The author said that, thanks to war-time conditions, it was not yet possible to compare initial costs of plants of similar power in steam reciprocating and turbine machinery and oil engines, but it was clear that the cost of oil engines was at least 30 per cent. above that of steam engines of equal shaft horse-power. The value of saving weight was rated higher in some trades than in others; the weight depended to some degree on the rating of the machinery and the extent to which it was overloaded; but, normally, turbines would be the lightest and oil engines the heaviest plant. The oil engine occupied less space at powers under 4000 brake horse-power, but the turbine took no more room than the oil engine at higher powers than 4000 brake horse-power. As regarded the reliability of gearing, experience gained in naval ships applied only to single reduction gearing, the larger ratios of reduction not being required in that class of ship. Gearing was now the item to receive attention if shipowners were to rely upon the turbine-driven ship. The author said that in 1919 the firm with which he was connected commissioned four firms to build eight steamers, two twin and two single-screw vessels with reaction type turbines, and two twin and two single-screw vessels with impulse type turbines. Each vessel of the two types was to be identical with its sister ships in dimensions, in lines, equipment, boiler dimensions, shafting, pumps, propellers, superheating, and all other auxiliary equipment, so as to provide a straightforward comparison between the performances of these turbines. Thanks to the conditions which had prevailed, three of these eight ships were yet to be delivered, and the comparisons were a very long way off completion. In spite of certain defects, the general results from the five vessels now running and an earlier, still more experimental, vessel were satisfactory.

BARROW-IN-FURNESS, Thursday.

Pig Iron.

There is not the same amount of life in the hæmatite iron market consequent upon the continuance of the labour troubles; yet, nevertheless, production has improved. The North Lonsdale Iron Company has put another furnace in blast at its works at Ulverston, and this places it in the position of having all its works engaged. This company has developed the casting of ingot moulds, which are being shipped from Barrow for South Wales in considerable quantities, apart from deliveries by rail. Other works are clearing all the iron smelted, while others are putting into stock. There is very little danger in this, as the price for mixed Bessemer numbers is not likely to fall for some considerable time. Deliveries of pig iron continue to the Continent *viâ* Antwerp, and other cargoes are seaborne to home ports. The steel works in the district continue to be consumers of iron, but this for the moment does not apply to Barrow. There are now thirteen furnaces in blast in the district.

Iron Ore.

The iron ore trade is dull and is not likely to improve much until there is a better trade in iron. None of the mines is fully at work nor are any likely to be so for some time. In the foreign ore trade there is a certain consumption, but nothing has arrived at Barrow for some time. Stocks in the district are being consumed gradually.

Steel.

The steel trade does not show any considerable activity. The Barrow rail mills are again held up by the bricklayers. A few weeks ago the Barrow company was able to secure the services of bricklayers from another district, and this enabled it to start again; but the local men brought them out and this led to another stoppage. The hoop works are not interfered with. There have been no further shipments of rails from Barrow.

SHEFFIELD.

(From our own Correspondent.)

Outlook Still Gloomy.

THE past week has brought little or no relief from the gloom which has enveloped the local industrial situation since the engineers' lock-out aggravated an already critical position. Manufacturers are getting very despondent, and evidence of this is afforded by the fact that in some of the big east-end works the staff and workmen who are not already out of employment have now received notice, accompanied by an intimation that their services for the future can only be retained on a day-to-day basis. In some cases departments are being entirely shut down. At the same time there is a growing feeling that if the present dispute could be cleared away a steady expansion of trade would follow. A moderate amount of local steel continues to be bought by Japan and India, and some of the crucible steel makers have commenced melting after a long stoppage, partly to cover orders and partly to renew small stocks. Users are afraid to order or to receive delivery of any description of raw materials, because of the uncertainty of being able to carry on their works. It is estimated that the Sheffield steel industry is at present working at only about one-fourth its capacity. Some encouragement is, however, afforded by the forecast

sent by so well informed and far-seeing an authority as Sir Robert Hadfield, who, writing from the South of France—where he is detained by ill-health—assured the shareholders of Hadfields, Limited, this week that the world to-day was short of no less than 200,000,000 tons of iron and steel. "There must therefore be a large demand before long, or modern civilisation will receive a check, for the world's progress depends on ample supplies of the metal and on a much greater scale than the present production." He added that for motor cars alone 1,000,000 tons of steel were worked up annually in America. In spite of the set-back caused by the cancelling of the battleship orders and the present industrial troubles, Sir Robert is confident that Sheffield will recover from the severe blow it has received.

Steel Developments.

Reference to the world's hunger for steel lends interest to a recent development of Sheffield's research work in steel which was referred to at the meeting of the Sheffield Association of Metallurgists and Metallurgical Chemists last week-end. Mr. J. F. Kayser in a lecture on cobalt steels said it had been discovered that the addition of cobalt to magnet steel enabled magnets to be made which were half the weight of the magnets made of ordinary tungsten magnet steel. The credit for this discovery was due to Sheffield investigators, for while it was quite true that Japan had brought out a magnet steel containing from 20 to 35 per cent. of cobalt, a short time before this a Sheffield steel was patented containing a much less percentage of cobalt with a high percentage of chromium, which was practically the equal of the Japanese material and less than half the price. This new steel was practically revolutionising the magneto industry, and also the telephone industry. People had not previously realised to what a tremendous extent the whole shape of a magneto or a telephone depended upon the magnet steels they were using. The soul of the instrument was the permanent magnet. Mr. Kayser also demonstrated the advantages of cobalt as an ingredient in high-speed tool steel. The revolutionary part the electric furnace is playing in the manufacture of steel has also been the subject of discussion by members of the West Yorkshire Metallurgical Society during the week. Mr. F. Rowlinson, lecturing on the present and future scope of the electric furnace in the manufacture of tool steel, said that it was no exaggeration to say that the electric steel furnace had had, and would have, as great an influence on the metallurgy of steel as had the processes of Huntsman, Bessemer, Siemens, Martin and Thomas. In this country at least the electric furnace was at present under a cloud—more particularly because of the high cost of current, because of unsatisfactory work turned out by half-trained operators who had not the experience in electric steel that the old-timers had in other processes, and chiefly because of the extravagant claims of some of the pioneers. It was still true that quality of the finished steel depended mainly upon the ingredients put into it, and not on what was refined out of it. The old crucible steel makers, therefore, chose their materials from the best in the world—the best steel-making Swedish irons, the best Sheffield blister bar, every piece hand-fractured and graded, the best Swedish white irons and the best Sheffield tool scrap. To this day the finest tool steel in the world—Sheffield crucible steel—was made only from the most expensive materials of unquestioned purity and quality. Comparing conditions in the electric tool steel industry, the lecturer said the electric furnace was a superb refining agent. Material of only moderate purity was charged and a steel was produced which on analysis and in appearance was exactly equivalent to the best crucible steel. But trial soon showed that it was deficient in quality. It lacked that indefinable "body" possessed by a high-class crucible steel. The claims that the electric furnace could be charged with any old scrap, provided it was steel, and that by clever chemical manipulation and elaborate refining a tool steel of the finest quality could be produced had done incalculable harm. The electric furnace could produce tool steel equal in every respect to the finest crucible steel, but the necessary precautions must be those taken in the making of crucible steel. In this connection, it is interesting to note that the Sheffield Steel Products steel plant is approaching completion. It is claimed that this will prove to be one of the most modern and economical in the country, including as it does every labour-saving device associated with modern steel works practice. The steel to be manufactured is to be mainly to supply the company's own needs, which are sufficiently large and diversified—including, in addition to table cutlery, files, saws, spanners, pliers and other small tools—to take the large proportion of the output of the new steel plant.

Lessons from Foundry Practice.

Concluding the series of lectures to foundrymen, Dr. Desch, Dean of the Faculty of Metallurgy at Sheffield University, offered to place the services of himself and his staff at the disposal of the men engaged in the Sheffield foundries to help them in solving the many difficulties which confront them. The casting of steel, he said, had received much attention from metallurgists in recent years, but that of iron was in a comparatively backward condition. The new processes for the manufacture of steel had only been made possible by a large amount of scientific research, and it was not to be doubted that if similar attention were given to the foundry greatly improved results would be obtained. Dr. Desch outlined a course of scientific instruction for the skilled men engaged in the trade and after some discussion—in which Dr. Desch, Dr. Hatfield and Dr. Longmuir were thanked for the lectures they had given during the course—it was decided to ascertain the views of the men engaged in the foundries on the matter.

A Slump in Farm Tools.

Although, as was shown in a recent letter, one firm has been very busily engaged on the manufacture of spades and shovels made of a special steel, which will bend without fracture and spring back to its original shape, this seems to be an almost isolated experience, for generally speaking the demand for farming and gardening implements had shown nothing of its customary seasonal activity. The business in tools and steel parts and cutters so far placed is far short of the average of even moderate years, and the season is now too far advanced to hope for much recovery. Farmers are evidently economising in view of prospective lean times ahead, and, moreover, are said to be fairly well equipped mechanically, while distributors report large stocks unsold last year. Nor is the demand from allotment holders anything like so big as in the war-time boom.

The Gas and Coal Position.

The Sheffield Gas Company has come to terms with the opponents to its parliamentary Bill, with the result that the basic price is to be 7d., instead of 9d. as originally proposed. But even this is nearly three times the pre-war figure, and in the view of local manufacturers still too high to warrant its use to any considerable extent for power or metallurgical purposes. In this connection, it is of interest to learn that Sheffield Steel Products, Limited, has recently been working with complete satisfaction a water-gas plant, by means of which, even with coke at its present high price, the company makes its own gas at a cost of 1s. per 1000 cubic feet. When it is remembered that the cost of fuel represents about 30 per cent. of the total costs of manufacturing most of the products of this firm, the importance of having an abundant supply of cheap gas in the operations of smelting, cogging, rolling, annealing, forging and hardening will be realised. The increasing use of still another alternative to costly coal is indicated by the Admiralty order just received by Moorwoods, Limited, of Harleston Ironworks, Sheffield, for the supply of two sets of oil-fired cooking ranges for H.M.SS. Emerald and Enterprise. The Admiralty has also purchased an oil-fired cooking range which was placed at its disposal for competitive tests at Devonport six months ago, and this is now being used for instructional purposes at the Devonport Naval School of Cookery. These ranges will be fired with crude fuel oil—bunker oil—using for the purpose the Kermode low-pressure system. A range which cooks for fifty men uses about half a gallon of crude fuel oil per hour, and it is said to be so odourless in use that bread can be toasted at the flame. More coal-getting records are being made on the South Yorkshire coalfield. The Brodsworth Main output for last week was better by 1100 tons than anything raised previously, and constitutes an easy record, the figure being 26,173 tons. Good progress is being made with the work of sinking the Harworth Main Colliery, near Bawtry—the pit in which Hugo Stinnes was chiefly interested before the war, and which was subsequently purchased by Barber, Walker and Co. The cementation process is employed with success to meet the water difficulties, and one shaft has been sunk to a depth of over 220 yards, and the second to over 150 yards. It is expected that the first coal measures will be reached at 240 yards, and the Barnsley bed of coal, which is to be worked, at between 900 and 1100 yards. The permanent ferro-concrete headstock is already erected and a beginning will shortly be made with the installation of the permanent winding engines. The original plan of the village was for 1500 houses, with church, club and institute and recreation grounds. The market for all classes of industrial fuels is at present, of course, on the quiet side; not only is there a daily falling off in inland demand, but the export business is also slackening. At many of the pits large stocks are accumulating, and short time working has had to be resorted to. The slack market is decidedly steadier, and collieries are making large reservations for use at boilers and coke ovens during the Easter holiday. Blast-furnace coke is not so active, although outputs are being taken up in a fairly satisfactory manner. The inland demand for purposes other than furnaces has enlarged in consequence of its use where gas coke was formerly bought, the price of the latter now being prohibitive for such purposes. Prices of all coals and coke remain unchanged.

NORTH OF ENGLAND.

(From our own Correspondent.)

Big Revival in Export Trade.

In the midst of so many disturbing influences, particularly through the disputes in the engineering and shipbuilding industries, it is encouraging to record a somewhat remarkable expansion in Cleveland's foreign trade in iron and steel. The official returns of exports for March reveal in a striking manner that the British manufacturers are once more securing a firm foothold in the markets of the world, and encourage the hope that the corner of depression in the export trade has at last been turned. For the first time since May, 1916, the aggregate shipments of pig iron, manufactured iron and steel from the Cleveland district have exceeded the 100,000 tons mark, the precise total being 101,747 tons. Never since the war has so much finished material been shipped abroad in a single month, and the aggregate for the past month is nearly 50 per cent. of the total for the whole of 1918. A few months ago the iron and steel export trade was in a very parlous state. Foreign manufacturers were not only underselling us in the European markets, but were flooding the home markets with their manufactures. That has now ceased. Employers and employed made enormous sacrifices in profits and wages, and prices were brought down to a level which permitted competition. In view of the fact that the home trade in manufactured iron and steel has suffered a marked contraction owing to the disputes in the engineering and shipbuilding trades, the revival in the foreign trade is particularly welcome.

New Avenues of Trade.

Another very encouraging feature disclosed by the returns is that Cleveland is not only recovering old markets abroad, but also cultivating new ones. This is evidenced by shipments of steel to the Argentine Republic, Peru, Mesopotamia, Brazil, and the Pacific Coast of Russia. The pig iron shipments for March totalled 43,001 tons, of which 29,940 tons went abroad. Increasing quantities have gone to the continental countries, Germany receiving 6380 tons, Belgium 6229 tons, France 5125 tons, and Italy 9225 tons. Last year Cleveland's average foreign shipments of pig iron were less than 6000 tons per month. The total shipped abroad last month is the biggest monthly total recorded since April, 1920, whilst the home and foreign shipments together have not been equalled since September, 1920. During the month no less than 52,613 tons of finished iron and steel were shipped abroad, the biggest aggregate since May, 1914. The principal customers were India 33,945 tons, Japan 3659 tons, Argentina 2318 tons, Cape Colony 1489 tons, China 1334 tons, Mesopotamia 1209 tons, Straits Settlements 1218 tons, and Peru 1045 tons.

Cleveland Iron Market.

Business on the Cleveland iron market has been extremely quiet this week. Hopes that the industrial troubles in the shipbuilding and engineering trades would be of short duration have not materialised, and home consumers are now disposed to await events before placing any more orders. Whilst it has been possible to maintain Cleveland iron prices owing to the very restricted output, competition for orders is tending once again to depress the price of hematite. Shipments are still heavy under contracts already fixed, but new export business is not now so brisk, and the engineering strike has played havoc with the home trade. When the changes which are taking place this week are completed there will be fifteen furnaces on the North-East Coast producing hematite pig iron, five on Cleveland iron, five on basic, and four on special iron—a total of twenty-nine. The make of Cleveland iron, it will be seen, is unusually restricted, and as a consequence the demand for No. 1 considerably exceeds the supply. Still, the little that is changing hands is being disposed of at 95s. per ton, whilst No. 3 Cleveland G.M.B. realises 90s., No. 4 foundry 87s. 6d., No. 4 forge 85s., and mottled and white 80s.

East Coast Hematite.

Some further shipments of hematite to Germany are reported, but the fall of the mark, and the advance in railway rates in Germany, tend to retard new business. The home demand, too, is very quiet, and some of the makers less favourably placed for orders are willing to cut prices. A fair average price for mixed numbers is now no more than 97s. 6d. per ton, though some makers ask more.

Iron-making Materials.

There is only a moderate business being done in foreign ore, and some of the steel-making firms are endeavouring to stop deliveries under contracts in view of the disturbed labour situation continuing for some time. Best Rubio is about 27s. c.i.f. Tees, but that price is regarded by consumers as too high. Coke makers refuse to make any further cuts, and 28s. 6d. to 29s. per ton remains the ruling price of good medium furnace coke delivered at the works.

Manufactured Iron and Steel.

Pessimistic reports are still given on the manufactured iron and steel trade. The unexpected prolongation of the engineering lock-out, and the virtual closing of the shipyards have led to a general suspension of specifications from home consumers, and deliveries have consequently declined. Only in the export branch is there any activity, and this, of course, is not sufficient to keep more than a small proportion of the plant employed. Nevertheless, there is not the slightest weakening in the general steel quotations. On the contrary, export prices are firmer and more nearly approximate to home quotations. With rather better business in corrugated galvanised sheets the price has advanced to £16 10s. per ton for 24 gauge.

The Coal Trade.

The Northern coal trade situation shows no improvement on the week. The easing tendency which has recently become conspicuous seems to proceed unchecked, and so far as appearances go, may continue to affect the current values adversely for some time longer. The acute labour and industrial crisis at home, added to the vast unemployment existing, is one of the causes of the *débâcle*, while the labour struggles in Sweden, Denmark and America all tend to dissipate that confidence and optimism which is absolutely necessary for the expansion of the overseas trade. The whole tone of the market has deteriorated, and with competition for the reduced home demand, together with a diminishing export inquiry, the present outlook is not rosy. The supplies in the hands of merchants are heavy, and though the collieries are endeavouring to make the best of the situation, there is no doubt that prices are not only lower, but are weak and susceptible to further discounting. Best Northumberland steams direct from the collieries are steady for the rest of this month, but in second hands for almost any date of shipment concessions can be worked. Second steams are also easy, though small steams are very steady. Best and special gas, together with selected brands of best bunkers, are fairly well placed, and are not much reduced, but coking and all secondary classes of gas and ordinary bunker kinds are moving in a downward direction. The coke position has also slackened off, and in all directions there are full supplies available, but these meet with a poor response, prices being weak.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

The depression in trade circles generally is reflected in the returns of shipping tonnage launched during the month of March and the figures indicating the work done during the first quarter of the year. From the Clyde yards there were launched during March fourteen vessels of 26,850 tons aggregate, compared with thirty vessels of 56,410 tons aggregate in March last year. For

the first three months of this year the returns show thirty-one vessels of 106,062 tons, compared with sixty-two vessels of 149,841 tons aggregate during the same period in 1921. The latter figures, however, were the highest on record for the first quarter of the year. Of the vessels launched during March, only four were about 4000 tons and upwards:—The Lassell, twin-screw motor ship, 7500 tons, for Lamport and Holt, Limited, Liverpool; the Durenda, twin-screw motor ship, 7400 tons, for the B.I.S.N. Company, Limited, London; the Nagasaki Maru, twin-screw geared turbine, 5400 tons, for the Nippon Yusen Kaisha, Tokio; and the Scholar, steamship, 3960 tons, for T. and T. Harrison, Liverpool. There is no demand for new ships at present, and the outlook is depressing.

Work Going Abroad.

A direct result of the engineering crisis and the trouble at the shipyards is the sending of vessels to Cherbourg or other continental ports for the completion of the fitting-out process. If the disputes are not settled immediately four vessels at least will be sent abroad for this purpose. During the strike of joiners last year, the Anchor Line steamer Cameronia had her passenger accommodation completed at Cherbourg, and the experiment was satisfactory to builders and owners alike. Further, a number of vessels due to go into dry dock for general overhaul and repairs will proceed on their outward journeys, and have any necessary work carried out at foreign ports. Consequently, dry docks which under different circumstances would have been occupied are lying empty with a corresponding loss of employment to a large number of men.

Contract for Cranes.

It is reported that Harland and Wolff, Belfast, have placed the contract for cranes in connection with their new repair works at the port of London with Alex. Chaplin and Co., crane makers, Govan, Glasgow. The contract includes electric overhead cranes of the three and four-motor type up to 40 tons, and also several monorail cranes. Messrs. Chaplin have just completed a contract for overhead cranes for Harland and Wolff's Clyde foundry at Govan.

Pig Iron.

Conditions in the Scotch pig iron trade are very dull. There are still only some twelve furnaces in operation, compared with eighty in normal times, but notwithstanding the low output, stocks in makers' yards continue to accumulate. A number of export inquiries are reported for foundry iron, but while home prices are now favourable, as compared with continental, the freight charges almost prohibit business, the cost in some instances from British ports being 8s. to 10s. in excess of the rate from continental ports. Scotch hematite nominally remains firm, but foundry qualities are easing gradually.

Finished Steel and Iron.

The Scotch steel and iron markets are merely marking time at present. There seems little doubt that business is being held up until a more settled state of affairs prevails, and buyers can operate with a certain amount of confidence in the stability of markets. A few orders are passing for certain materials, but these are only for absolute requirements, and have little or no effect on markets, and provide small employment for the works. Steel works are feeling keenly the lack of specifications for plates and sectional material, and it is reckoned that not more than 20 per cent. of the total capacity of the works is in operation. Steel sheets—both plain and corrugated—have done some more export business of late, but in most instances very low prices have been accepted. There are indications of more movement from Japan, India and South America. Bar iron works are no better off than the steel works, and iron and steel tube makers and producers of iron and steel castings are likewise poorly employed.

Coal.

The home demand for Scotch coal has been on meagre lines for a considerable period now, and since the export turnover has dropped considerably during the past week or two, conditions have been very dull. For some time now the demand for export fuel has in a measure compensated for the loss of local business, but the sudden collapse of the former has caused great depression in the trade. Fuel of all descriptions is plentiful, and prices are very irregular, holders in some instances undercutting colliery prices. The only exceptions are single nuts and pearls. Colliery sidings are becoming blocked with loaded wagons, and every day sees an increase in idle time. House coal is exceedingly quiet, and prices are very fluctuating. In certain districts fuel which was 2s. 1d. to 2s. 3d. per cwt. can be bought to-day at 1s. 7d. and 1s. 8d. per cwt. bag in single lots. Shipments are good, but under present conditions must soon show a considerable reduction. Aggregate clearances were 260,955 tons, against 231,156 tons in the preceding week and 317,147 tons in the same week last year. Total shipments for the first quarter of this year show an increase of 1,345,363 tons, as compared with the same period in 1921.

Miners' Wages.

At a meeting of the District Board of the coal industry of Scotland, held in Glasgow during the week, the independent accountants' joint report relating to the ascertainment based on the results of February, in terms of the report on wages payable for April, was submitted. The wages payable will be basis rates plus 113.73 per cent., an increase of 3.73 per cent. on the basis rate, compared with March. This percentage represents 8s. 6½d. per shift in Lanarkshire.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

WITHOUT displaying any marked change, the coal market is quite firm. Since I wrote a week ago, it has received temporary support from an unexpected quarter, inasmuch as the severest snowstorm experienced in this district for the past thirty or forty years swept South Wales on Friday and Saturday last, and interrupted work at the collieries, on the railways and at the docks. Thousands of colliers could not get to the pits because the trains were unable to run, and it was impossible for tipping operations to be carried on at the ports, with the result that wagons could not be emptied. These conditions reacted adversely on the collieries, and many were unable to work in the early part of the week. With the Easter holidays so near, it is unfortunate that production should have been interfered with, as coals are badly needed, and, of course, the holidays in a week's time will mean the loss of the best part of a week's output. The shortage of coals has strengthened the market without actually causing prices to harden, except in a few isolated cases, although superior small coals are rather better in price. Furthermore, the commencement of the strike of the American miners on Saturday last has had a sentimental effect on the market in the direction of improvement, although this has not so far taken definite shape. If, however, the stoppage lasts some time, it will undoubtedly result in a considerable expansion in the demand for coals from this district, and values will advance. From all accounts, America is very well supplied with coals, but this is not believed to be the case as regards her customers, and it is from Canada, Central America and the West Coast that orders are likely to come in the course of time, while the mere fact that there is the probability of prices improving consequent upon the extra inquiry from these quarters is also calculated to have a stimulating effect upon the demand from Italy, France and other European markets. At the moment, there is not much fresh business so far as Italy and France are concerned. The former country is overstocked for the time being, and the few buyers who are in the market are only offering prices which are about 2s. per ton below the actual cost of shipping cargoes out there. Until the present stocks are absorbed, there can be no very great demand from Italy, and it is to be feared that there will not be very much done this month; but if the American strike lasts any length of time, next month may see an appreciable improvement in the conditions prevailing on this market. So far as the anthracite section is concerned, colliery owners look forward to being even more favourably situated, and for this reason they are very careful what sales they commit themselves to, and are already asking higher prices for early loading, while for May shipment they will not in most cases quote at all.

German Competition?

The report has been in circulation that Germans are entering the field of competition in the export trade on a big scale. It started with the announcement that a group of leading German business men contemplated the purchase of an exceptional quantity of South Wales coals for shipment "to Germany," but one very important fact was overlooked in giving publicity to this, viz., that with the high rate of exchange now ruling, German consumers would never be able to entertain the acceptance of coals at the price which would be entailed, as it would mean that the coals would cost them over £100 per ton delivered. Germany is not in need of coals to such an extent to justify purchasing on this basis, if, indeed, she requires any coal at all from this district. South Wales coals have been going to Hamburg and other German ports, but these have been for the purpose of bunkering surrendered German vessels and British steamers which have been undergoing repair in Germany. The probability of German business men taking a more active part in the export of coals from South Wales to South American and Mediterranean destinations is a more likely proposition, and, in fact, they have been doing so for some time past, although not so openly as was the case before the war. Nothing definite, however, can be gleaned as to the Germans becoming more active, but it is stated that some local exporters have been making efforts to secure the option on a large quantity of coals for shipment during the next three months. It is questionable whether their efforts will prove successful, as this way of doing business is not very satisfactory. Colliery salesmen are prepared to sell their coals, but to give an option is not a workable proposition, as they would be tied up and never know whether their coals are going to be lifted or not.

Working Hours at Docks.

The unfortunate part about the whole situation as it at present stands is that, assuming that there is a big demand for coals from this district, and the chance exists of full employment being given to the whole of the miners in South Wales, the fact remains that if a materially larger output of coals took place, shipment of the increased quantity could not be effected at all satisfactorily, as the facilities at the docks are not equal to it. There would certainly have to be a revision of the working hours, to which the coal trimmers and tippers will not agree. There has been a further conference between the representatives of the men and the employers, but the former adhered to the present hours of working. They offered to extend the working hours by one, in order to enable them to take a half-hour for meals in each shift, thus giving a full eight-hours' work, it being contended that with a general tightening up all round this would meet the requirements of the trade. The employers could not, however, accept this view, and agreed that a joint report should be presented to the adjourned national conference, which takes place in London on the 7th inst.

Steel Workers' Wages.

It is reported that as the result of recent negotiations, an important agreement has been arrived at between the South Wales and Monmouthshire Iron and Steel Manufacturers' Association and the South Wales Allied Trades' Association for the regulation of wages during the next six months. According to Mr. David Evans, of Ebbw Vale, the organising secretary of the skilled workers, the present rate of wages is to continue until the end of April. Then as from May 1st until the end of September of this year the rate for fully qualified journeymen will be 41s. base, plus a make-up of 24s., making a total of 65s. per week of forty-seven hours. This is a reduction of 5s. from May 1st to the end of September, and there will be proportionate reductions in the wages of the other grades under the allied skilled trades schedule. The agreement has been placed before a mass meeting of the men at Ebbw Vale, and they have agreed, subject to certain minor matters being referred to the joint sub-committee, to accept it.

Iron Ore in South Wales.

The announcement is made that the Hendy Hematite Iron Ore Company has struck a large pocket of valuable iron ore at Pontyclun, where prospecting has been in operation for upwards of two years. It is estimated that this pocket contains many thousands of tons of rich deposit. It is near the Great Western and Taff Vale railways, at Pontyclun. A short length of tramroad is to be constructed immediately to connect up the outlet of the mine with the railway system. Up to now only about twenty men have been employed at the level, but it is calculated that as the result of developments, this number will be considerably increased. Mr. J. Fox Tallis stated at a recent meeting of the South Wales Institute of Engineers that there is a total quantity of workable iron ore in the South Wales coalfield of about 10,000 million tons.

Current Business.

The coal market is practically featureless from the point of view of any appreciable variation in prices, but the conditions have been disturbed by the uncertainty of being able to get coals, as a result of the restricted working of collieries during last week-end. Tonnage has also been delayed, and altogether loading arrangements have been dislocated. Vessels in dock have experienced no little amount of detention, because of coals not being to hand to continue working, and the demand for supplies following the short working at the pits has given a rather firmer tone to the market. Small coals have certainly become scarcer, and are a shade higher in price at 19s. 6d. to 20s. for the best qualities. Few collieries are prepared to quote ahead unless they can get a good price, and this is especially the case with anthracite producers, who even for prompt shipment have advanced their price from 28s. to 30s. for big vein large coals, and are not inclined to sell for May loading, as their view is that values may easily go up 10s. per ton. There is no change so far as patent fuel and coke are concerned, though pitwood is a shade easier at 29s. to 30s.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES

Miners' Holidays.

It has been agreed that the miners shall take two days' holiday at Easter, viz., Monday and Tuesday, the 17th and 18th inst., while the men will also take Monday, May 1st, as their annual demonstration holiday.

Swansea Metal Exchange.

A better tone prevails in the Welsh steel and tin-plate trades as the outcome of a more extensive inquiry for tin and black plates, and prices are firm on the basis of 19s. 6d. to 19s. 9d. for prompt, and 19s. 3d. to 19s. 6d. I.C. f.o.b. basis for forward delivery. There is some talk of an advance in the prices of Welsh bars. The official minimum is £7 7s. 6d. per ton delivered for the Siemens' brand, but it is questionable whether leading steelmakers favour increasing the price, and in this way handicapping the tin-plate trade.

Colliery to be Closed.

Notices served to the workmen engaged at the Prince of Wales Colliery, Ebbw Vale, expired on Wednesday, and it is reported that they will take effect and the colliery be closed down as it is unremunerative. About 1100 men are affected.

WAR MEMORIAL FOR AUCKLAND, NEW ZEALAND.—The city of Auckland is proposing to erect a war memorial in the form of a museum and institute, for which it is calling for competitive designs. The date for receipt of designs in Auckland is June 30th, 1922, on or before which date all designs must be in the hands of Mr. T. F. Cheeseman, Curator, Museum, Princes-street, Auckland. Copies of conditions for competitive designs may be seen on application to the Department of Overseas Trade (Room 41), 35, Old Queen-street, Westminster, London, S.W. 1.

CONTRACTS.—Vosper and Co., Limited, of Portsmouth, have secured a contract from the Crown Agents for the Colonies for two composite tugs for Mauritius. The vessels are of the following dimensions: 65ft. overall, 14ft. beam, 5ft. draught.—The contract for 500 pairs of wheels and axles, for which tenders were invited by the Siamese State Railways in February last, has been placed in Belgium with the Aciéries de Haine-Saint-Pierre et Lesquin, which submitted the lowest offer, and the agents of which in England are Messrs. G. F. West and Co., Iddesleigh House, Westminster, London, S.W. 1.—George Kent, Limited, of Luton, has just received an order from the Metropolitan Water Board for three Venturi meters, each 108in. diameter, together with recorders, &c., for the new Littleton Reservoir. These meters, when installed, will be capable of metering upwards of 300 million gallons per day, and will be the biggest so far put down in the United Kingdom, and the second largest ever manufactured in this country, the largest being 120in. diameter, supplied by the same firm for the Divi irrigation works, Madras, some fifteen years ago.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	23/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 5 0	—
No. 1 Foundry	4 15 0	—
No. 3 ,,	4 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 17 6	4 17 6
No. 1	4 18 6	4 18 6
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands.		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
Part Mine Forge	*None offering.*	
North Staffs. No. 3 F'dry	4 5 0 to 4 10 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 0 0	—
,, Forge	3 10 0 to 3 12 6	
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 12 6 to 3 15 0	
(3 Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
4 N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0 to 5 15 0	

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
Scotland—		
Crown Bars	11 0 0	—
Best ,,	12 0 0	—
N.E. Coast—		
Common Bars	12 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	12 0 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
Midlands—		
Marked Bars (Staffs.)	14 10 0	—
Crown Bars	11 10 0	—
Nut and Bolt Bars	10 7 6 to 10 10 0	
Gas Tube Strip	11 15 0 to 12 0 0	
Hoops (*Nom.*)	14 0 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
5 Scotland—		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ⅜in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 10 0

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 10 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
Manchester (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 15 0	—
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
Midlands—		
Small Rolled Bars	9 5 0 to 9 10 0	
Bessemer Billets	7 10 0 to 7 15 0	
Hoops	12 0 0	—
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (24 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 5 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/6 to 19,9
Block Tin (cash)	143 12 6
,, (three months)	145 2 6
Copper (cash)	57 2 6
,, (three months)	57 7 6
Spanish Lead (cash)	21 15 0
,, (three months)	21 5 0
Spelter (cash)	25 12 6
,, (three months)	25 15 0
Manchester—	
Copper, Best Selected Ingots	62 10 0
,, Electrolytic	64 10 0
,, Strong Sheets	90 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11¾
,, Condenser	0 1 2¾
Lead, English	23 5 0
,, Foreign	21 15 0

FERRO ALLOYS,

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/6 per lb.	
Ferro Tungsten	1/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£88	31/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	20/6
,, ,, Ell	21/3
,, ,, Splint	22/- to 25/-
,, ,, Trebles	21/-
,, ,, Doubles	20/-
,, ,, Singles	18/6
Ayrshire—	
(f.o.b. Ports)—Steam	20/6
,, ,, Splint	22/-
,, ,, Trebles	21/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	18/6 to 22/6
Screened Navigation	27/-
Trebles	21/6
Doubles	20/-
Singles	19/-
Lothians—	
(f.o.b. Leith)—Best Steam	20/6
Secondary Steam	20/-
Trebles	21/-
Doubles	20/-
Singles	19/-

ENGLAND.

(8) N.W. Coast—	
Steams	23/-
Household	40/- to 55/-
Coke	34/-
Northumberland—	
Best Steams	23/- to 24/-
Second Steams	22/- to 23/-
Steam Smalls	14/- to 15/-
Unscreened	21/6
Household	25/- to 30/-
Durham—	
Best Gas	23/-
Second	21/- to 22/-
Household	25/- to 30/-
Foundry Coke	32/6 to 35/-

	Inland.
Sheffield—	
S. Yorks. Best Steam Hards	22/- to 23/- —
Derbyshire Hards	21/- to 22/- —
Seconds	20/- to 21/- —
Cobbles	19/- to 20/- —
Nuts	17/- to 18/- —
Washed Smalls	11/- to 12/- —
Best Hard Slacks	12/- to 13/- —
Seconds ,,	10/- to 11/- —
Soft Nutty ,,	9/- to 10/- —
Pea ,,	7/- to 8/- —
Small ,,	4/- to 5/- —
House, Branch	37/- to 39/- —
,, Best Silkstone	34/- to 35/- —
Blast Furnace Coke (Inland and Export)	17/6 to 22/6

(9) SOUTH WALES.

	Export.
Cardiff—	
Steam Coals:	
Best Smokeless Large	27,6
Second ,, ,,	27/-
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	24/- to 25/-
Best Black Vein Large	26/6 to 27/-
Western Valley ,,	26/- to 26/6
Best Eastern Valley Large	26/- to 26/6
Ordinary ,, ,,	24/- to 25/
Best Steam Smalls	19/- to 20/-
Ordinary ,,	15/- to 19/-
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	19/6 to 20/-
No. 2 ,, Large	23/6 to 24/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	16/- to 18/-
Coke (export)	30/- to 35/-
Patent Fuel	24/6 to 27 6
Pitwood (ex ship)	29/- to 30/-
Swansea—	
Anthracite Coals:	
Best Large	37/6 to 40/-
Seconds	30/- to 35/-
Red Vein	28/- to 30/-
Big Vein	37/6 to 40/-
Machine-made Cobbles	45/- to 47/6
Nuts	47/6 to 50/-
Beans	47,6 to 50/-
Peas	22/6 to 25/-
Breaker Duff	10/- to 10/6
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 22/6
Smalls	13/- to 18/-
Cargo Through	18,6 to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Import Duties.

A LITTLE firmer tone has been given to the market by the successful termination of the prolonged negotiations for the constitution of the Comptoir to control the prices, and to a certain extent the production, of iron and steel in the eastern departments, including Lorraine, and thereby replacing the old Longwy syndicate. Mill and forge owners, however, complain that there can be no active recovery until they are protected from foreign competition by higher import duties, which they pretend are relatively lower than those before the war. It is certain that a great deal of foreign iron and steel is finding its way into this country, to the satisfaction of constructive engineering firms, which state that the only hope of an improvement in trade lies in a reduction of prices following upon cheaper supplies of raw material. The mill and forge owners, therefore, find their plea in favour of increased import duties strongly opposed by consumers, and the necessity of obtaining cheaper supplies of raw and semi-manufactured material is, in fact, so generally recognised that a reduction in the import duties is already under consideration, while the railway administration is doing all it can to reduce, as far as possible, the railway charges in favour of consumers situated at long distances from the centres of supply. This is especially the case with the shipbuilding firms. If the mill and forge owners are complaining of foreign competition, the colliery proprietors find themselves in a still worse position, for with the prices at which imported coal is sold the French collieries are unable to dispose of their output, with the result that stocks are accumulating heavily. In Nord and the Pas de Calais the outlook is regarded as very precarious unless the men will accept lower wages, although it is hoped that the situation will improve somewhat if the proposed modification of the Bill whereby the men are to work eight hours "at face" instead of from bank to bank comes into effect.

Manufacturing Costs.

The complaint of foreign competition, even from countries with appreciated currency, confirms what has long been evident, that a depreciation of money values does not mean a corresponding diminution of manufacturing costs. In a general way, manufacturers who buy everything on the home market and pay wages in a depreciated currency can produce at smaller cost than makers in countries with a lower exchange rate. It is perhaps a coincidence that the countries in which money values are low are for the most part those which have most work available, either for home reconstruction or for supplying material as reparation, and they have consequently not the same incentive to bring down prices as exists in countries with an appreciated currency that depend for their industrial activity upon export business, which is at present almost entirely lacking. As the export business is only obtainable by lowering prices, wages and everything else must be reduced, with the result that the economic conditions are becoming more normal, while in this country they are still completely upset by the inflated currency. Considerable efforts have been made to bring down prices, but nothing can be done while the low money values increase the cost of living and there is a falling off in individual production. During the past few months manufacturing costs have steadily increased, chiefly through the advance in raw material prices. Therefore it follows that while countries depending upon an export trade are obliged to effect every possible economy in order to secure business, the cost of production in this country has actually increased, the result being that the home industry must be protected from foreign competition by import duties. The only way at present of bringing down costs is to offer preferential railway rates for raw material and goods for export, and also to modify the application of the eight hours' Bill. As for the cost of living, upon which wages are based, it can only be reduced by a gradual deflation of paper currency.

Railway Council.

The first meeting of the Superior Railway Council, which now controls the railway administration of the whole country, was held recently at the Ministry of Public Works, when the Minister, M. Le Trocquer, referred to the various questions that would have to be dealt with, such as the construction of new lines. That, he said, would have to be carried out with a great deal of prudence on account of the financial difficulties, although the Council would have to discuss at an early date the question of securing direct and uninterrupted communication between Switzerland and the Atlantic ports. The organisation of the State railways, which are to be handed over to a company, is another matter that will have to be dealt with by the Council, and in this connection there is a good deal of agitation amongst commercial bodies at Nantes and in other centres against the rejection of the application of the Paris-Orleans Company to take over the State lines in Brittany over which it has running rights. The various commercial and industrial associations affirm that it is far better to leave the working of the lines in the hands of a company which is already giving satisfactory results rather than to farm it to a new company of which the organisation has to be created. At its first meeting the Council was only able to come to one decision over the question of the advanced railway rates which are to remain in force until November 1st, by which time it is hoped the Council will have found a means of effecting certain reductions, especially in the charges for raw material. The idea is to bring the freights down as low as possible compatible with the financial position of the companies, and the only way of doing that is to make sure that a reduction of rates will result in a proportionate increase of traffic. The Midi Company has been authorised to issue debentures for carrying out its electrification and other schemes, and the P.L.M., which has in hand some very extensive improvement works, as well as the electrification of lines in the south, has issued debentures in London—the first time, I believe, that this has been done by a French railway company.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

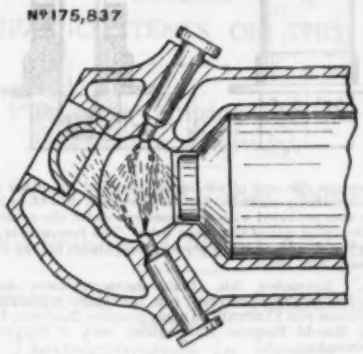
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

175,837. December 20th, 1920.—FUEL INJECTORS, Sir K. J. Crossley and W. Le P. Webb, Crossley Brothers, Limited, Openshaw, Manchester.

IN order to increase the turbulence of the mixture in the combustion chamber, and thus improve the mixing of the fuel

N°175,837



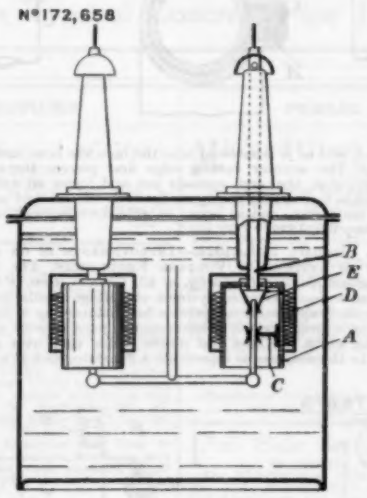
and air, the inventors provide two oil sprays, as shown. The orifices of the sprays are so disposed that the several jets from each of the sprays do not collide seriously.—*March 2nd*, 1922.

SWITCHGEAR.

172,658. December 12th, 1921.—OIL BREAK ELECTRIC SWITCH WITH RESISTANCE, The Oerlikon Company, of Oerlikon, near Zurich, Switzerland.

The oil switch is placed within a bell-shaped member A, which acts as a gas collector, and the gases which are formed whilst the switch is in operation are conducted out of the sealing box through a tube B. Within the part A is a stop contact C, to which one end of the resistance D is connected, whilst the

N°172,658



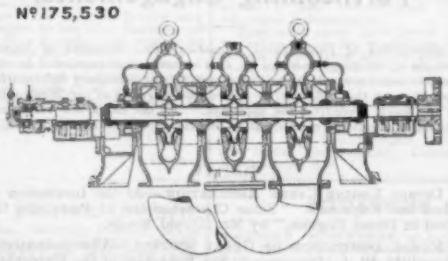
other end of the resistance is connected to the main contact E The object of the invention is to enable resistance to be introduced into the circuit when the current is being interrupted without using a switch chamber of increased size.—*March 2nd*, 1922.

PUMPING AND BLOWING MACHINERY.

175,530. February 10th, 1921.—MULTI-STAGE CENTRIFUGAL PUMPS, Mather and Platt, Limited, Park Works, Manchester, and T. Y. Sherwell, jun.

The inventors claim that the form of pump shown in the illustration is both efficient and economical in construction. It is virtually a number of individual centrifugal pumps, with

N°175,530



a common shaft and only two bearings, having the delivery branch of each pump connected with the suction of the next by means of external pipes.—*February 23rd*, 1922.

175,898. February 21st, 1921.—BOILER FEED PUMPS, C. Barrance, 9, Oak-terrace, Newcastle-road, Leek.

The illustration shows the relative positions of the main steam piston B, the slide valve C and the piston valve G of this pump when the piston B has reached the bottom of its stroke. When nearing the bottom of its stroke, it engages the slide valve C and pushes it down into the position shown, thus admitting steam from the centre portion of the cylinder A to the top side of the piston valve G through the port E. The exhaust steam from the bottom of the main valve escapes through the ports F^1, J—in the slide valve C—and K^1 to the main exhaust M. The piston valve G is thus forced into the bottom position, as shown, and allows steam to be admitted to the bottom of the piston B through the regulating valve S and the ports R, W^1 and Y^1. The exhaust steam from the opposite end of the piston B escapes through the ports W and X to the main exhaust M. As the piston B approaches the top of its stroke, its top piston ring closes the port W and traps a portion of the exhaust steam. This has a cushioning effect

N°175,898

Fig. 1.

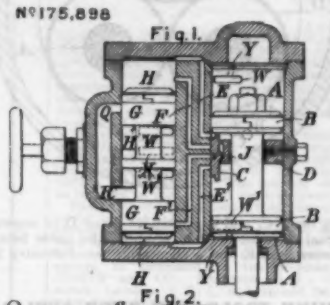
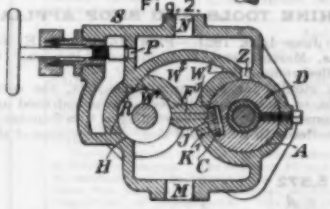


Fig. 2.



upon the piston B, as the trapped steam only escapes gradually through the small auxiliary port Y. When the piston B has reached the top of its stroke, the slide valve C has been pushed upwards and steam admitted to the bottom of the main valve G from the centre portion of the main steam cylinder A through the port E^1. The valve G is thus forced into the top position, the exhaust steam from the top of the valve G escaping through the ports F, J—in the slide valve C—and K^1 to the main exhaust M. In the top position the valve G allows steam to be admitted to the top of the piston B through the regulating valve S and the ports Q, W and Y, the exhaust steam from the bottom of the piston B escaping through the ports W^1 and X to the main exhaust M, and, after the port W^1 has been closed by the downward travel of the bottom piston ring, through the small auxiliary port Y^1, which produces a cushioning effect upon the piston B. The cycle of operations is then repeated.—*March 2nd*, 1922.

MEASURING AND TESTING INSTRUMENTS.

175,900. February 22nd, 1921.—A FINE MOTION DEVICE FOR INSTRUMENTS, E. G. Fischer, The Ethelhurst Apartments, Fifteenth and L Streets, N.W. Washington.

In the place of the usual tangent screw arrangement for making the fine adjustments of sextants and similar instruments, the two little handles A and B are employed. A is fixed to the vernier arm, while B is on a block C, which can

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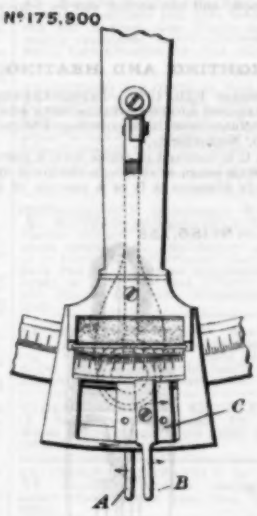


be clamped to the arc of the instrument when the arm has been set in its approximate position. The two handles A and B are then grasped by the thumb and finger, and a rotary movement of the hand used to give the final adjustment.—*March 2nd*, 1922.

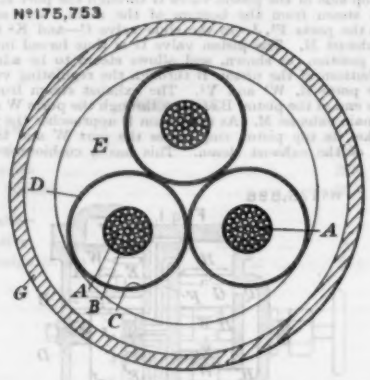
TRANSMISSION OF POWER.

175,753. November 20th, 1920.—IMPROVEMENTS IN AND RELATING TO THE CONSTRUCTION OF HIGH-TENSION CABLES, W. T. Henley's Telegraph Works Company, Limited, of 13 and 14, Blomfield-street, London Wall, E.C. 2, Percy Dunsheath, of W. T. Henley's Telegraph Works Company, North Woolwich, E. 16, and Charles Grover, of 48, Kent-road, Gravesend, Kent.

This invention relates to the construction of high-tension cables designed to work at pressures of, say, 20,000 volts, and which are usually provided with insulation composed of a dielectric substance impregnated with oil or with a compound or compounds, and the primary object is to overcome various disadvantages in the construction of such cables, the chief being the difficulty which is experienced in satisfactorily impregnating the thick layers of the dielectric employed. Each stranded

conductor A is enclosed in a separating layer B, and is afterwards lapped round with paper in the usual way. After the core has been impregnated, it is enclosed in a non-metallic

No 175,753



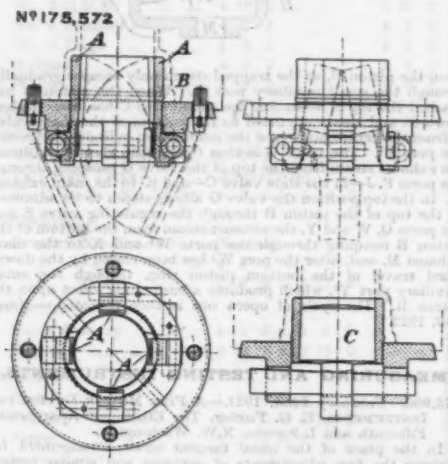
separating layer C, and a protective layer D of impregnated or unimpregnated paper is then applied, the cable being finished off with wormings E and a sheathing G.—*February 20th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES

175,572. June 14th, 1921.—Pipe Moulds, J. E. James, The Villas, Marton, and I. Williams, "Poplars," Grove-hill, Middlesbrough.

In this mould, for casting pipe sockets, the core is made collapsible, so that it may be withdrawn and used again. The four sections of the core A A are hinged to a foundation ring B, which is cottered to the mould box. The sections of the core are

No 175,572



expanded and held in place by a tapered plug C, secured by a wedge as shown. When a cast has been made, the core is collapsed, as shown by the dotted lines, the foundation ring is taken off the box, and the socket can be removed.—*February 23rd*, 1922.

LIGHTING AND HEATING.

155,238. November 12th, 1920.—Improvements in or relating to Electric Light Installations for Alternating Current, Naamlooze Kennootschap Philips' Glocilampenfabrienken, Netherlands.

A condenser C is inserted in series with a portion of the filament of an electric lamp, as shown in the lower drawing, so that either the whole filament A B or a portion of it A D may be

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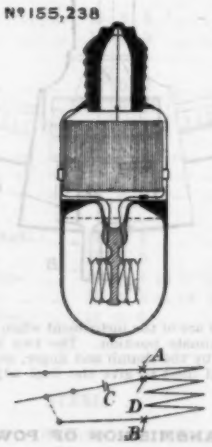


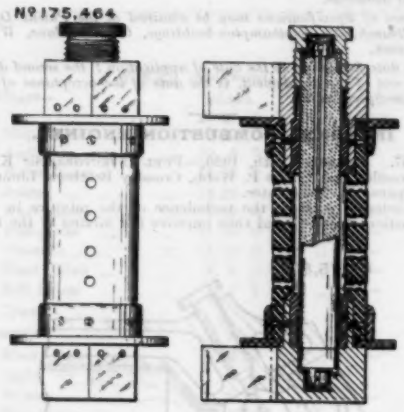
connected to the alternating supply circuit. The lamp may therefore be made to give a high or low candle-power without any appreciable loss of energy. The condenser is incorporated in the upper part of the lamp, as shown in the upper illustration.—*February 13th*, 1922.

MISCELLANEOUS.

175,464. September 6th, 1921.—Improvements in and relating to Fuses for Electric Circuits, William De Renzi and John Adamson, of the Hamilton Engineering Company, of Muir-street, Hamilton, Lanarkshire.

The fuse described in this specification consists of an inner tube or cartridge of insulating and refractory material, through which the fuse wire is threaded, and an outer tube of insulating material having contact blocks adapted to fit into and make contact with the usual contact clips or jaws. The inner tube or cartridge is provided at each end with a metal ferrule, having projecting nipples, and round which the fuse wire is passed. One contact block of the outer tube is provided with a stepped recess to

No 175,464

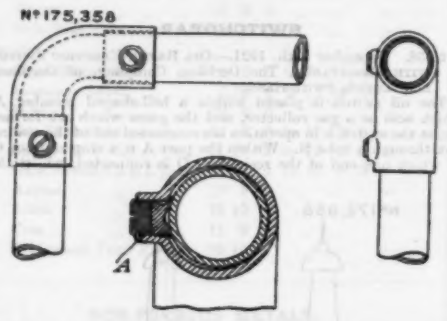


accommodate one end of the inner tube and the other contact block is internally threaded for the reception of a thumb screw, which is also provided with a stepped recess for the accommodation of the other end of the inner tube. The fuse wire is gripped between the shoulders of the recesses and those of the ferrules. —*February 3rd*, 1922.

175,358. November 5th, 1920.—Improvements relating to Continuity Devices for Metallic Conduits and Fittings for Electric Cables, Simplex Conduits, Limited, and Harold Fletcher McLoughlin, both of Garrison-lane, Birmingham.

Each of the sockets of the fittings—such as couplers, bends, tees, junction boxes, &c.—is provided with a radially disposed tapped hole A, with a boss, as shown in the sectional view, and into this hole a stud or grub screw is inserted. The screw

No 175,358

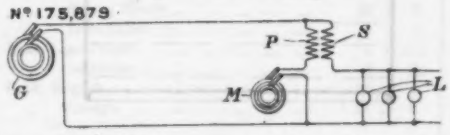


is cupped, and as it is screwed into the hole the nose meets the conduit. The annular cutting edge first pierces the enamel and afterwards the end spreads out and forms an extended fin, which is forced into the space between the conduit and the bore of the socket, and so forms an efficient electrical contact. —*February 6th*, 1922.

175,879. January 24th, 1921.—Improvements in or relating to Systems of Voltage Regulation, *The British Thomson-Houston Company, of 83, Cannon-street, E.C.*

This invention relates to systems of voltage regulation, and is particularly applicable to systems for maintaining a constant voltage on a circuit which is connected in parallel with another circuit in which the load and power factor vary over a wide range. In the diagram G represents a generator and M a motor

No 175,879



representing the variable power factor load. A transformer with primary and secondary windings P and S respectively is connected to the load L in the manner shown, and this load is supplied at practically constant voltage. The series transformer used is specially constructed so that the magnitude of the voltage induced in the secondary winding and the phase relationship between the voltage in the secondary winding and the current in the primary winding may be accurately adjusted. —*March 2nd*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Diesel Engine Users' Association.—At the Institution of Electrical Engineers. "Some Characteristics of Petroleum Oil Used in Diesel Engines," by Mr. Harold Moore.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse. "The Evolution of the Elements," by Sir Ernest Rutherford. 9 p.m.

Junior Institution of Engineers.—Caxton Hall, S.W. 1. Lecturette, "Engineering in Southern Persia," by Mr. J. W. Maple. 8 p.m.

Institution of Costs and Works Accountants: Birmingham and District Branch.—Chamber of Commerce, New-street, Birmingham. Public lecture on "The Functions of Works Accountancy," by Mr. J. A. Lacey. 7.30 p.m.

SATURDAY, APRIL 8TH.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. "Radioactivity," by Sir Ernest Rutherford. (Lecture VI.) 3 p.m.

The North of England Institute of Mining and Mechanical Engineers.—Lecture Theatre of the Institute, Newcastle-on-Tyne. The following paper will be open for discussion: "Experiments with Single-inlet, Duplicate, and Double-inlet Capell Fans," by Mr. E. Seymour Wood, M. Inst. C.E. The following paper will be read: "The Limestone Coal Reserve of North Northumberland," by Mr. R. C. Carruthers. 2 p.m.

MONDAY, APRIL 10TH.

Institution of Locomotive Engineers.—Philosophical Hall, Park-row, Leeds. Paper: "Modern Production and Costing Methods as Applied to Locomotive Engineering," by Mr. A. E. Howell. 7 p.m.

Institute of Transport.—The Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. Paper, "The Relation of Civil Engineering to Transport Problems," by Sir Alexander Gibb. 5.30 p.m.

TUESDAY, APRIL 11TH.

Institution of Electrical Engineers: Scottish Centre.—207, Bath-street, Glasgow. Paper: "Rotary Converters, with Special Reference to Railway Electrification," by Mr. F. P. Whitaker. Annual general meeting. 7.30 p.m.

Manchester Metallurgical Society.—College of Technology, Manchester. Paper: "The Causes of Some Defects in Steel," by Dr. Thomas Swindon. 7 p.m.

Institution of British Foundrymen: Burnley Section.—Technical College, Ormerod-road, Burnley. Paper: "Some Experiences of Cupola Practice," by Mr. J. Pell. 7.15 p.m.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Annual general meeting. 7.30 p.m.

Institution of Automobile Engineers.—Visit of the London Graduates to the works of Clement Talbot, Limited, Barlby-road, Ladbroke Grove, W. 10. Meet outside the works at 2.30 p.m.

Institution of Automobile Engineers: Coventry Graduates.—Broadgate Café, Coventry. Paper, "Valve Gearing," by Mr. W. L. Maltby. 7.45 p.m.

British Section of the Societe des Ingenieurs Civils de France.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Presidential address by Mr. W. Noble Twelvetrees, M.I. Mech. E., A.M.I.E.E., opening a discussion on "Co-operation between Engineering Institutions in France and Great Britain." 5.30 p.m.

Institution of Petroleum Technologists.—The Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper on "Galicia and its Petroleum Industry," by Mr. Albert Millar. 5.30 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Paper, "The Results of a Microscopical Examination of Batt and other Kindred Substances in Coal Seams," by Mr. James Lomax. (Illustrated by lantern.) 4 p.m.

The Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Annual general meeting. 7.30 p.m.

TUESDAY, APRIL 11TH, TO THURSDAY, APRIL 27TH.

Building Trades' Exhibition.—Olympia.

WEDNESDAY, APRIL 12TH.

Junior Institution of Engineers.—Official visit to the International Building Trades' Exhibition at Olympia. 5 p.m.

Institution of Automobile Engineers.—Institution of Mechanical Engineers, Storey's-gate, St. James' Park, S.W. 1. Ordinary general meeting. Paper: "Marine Engine Design as Affected by Lifeboat Service Conditions," by Mr. A. F. Evans. 8 p.m.

The Association of Engineers-in-Charge.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Paper on "The Artesian Wells and Geological Strata of London," by Mr. R. Langton Cole, F.R.I.B.A. 7.30 p.m.

TUESDAY TO FRIDAY, APRIL 18TH TO 21ST.

The Concrete Institute.—Building Exhibition, Small Conference Hall, Olympia. For programme see page 354. 5.30 p.m. each day.

FRIDAY, APRIL 21ST.

Institute of Transport.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Lecture: "The Operation of a Large Tramway Undertaking, with reference to Capacity and Cost Under Given Conditions," by Mr. J. K. Bruce. 5 p.m.

WEDNESDAY, APRIL 26TH.

Society of Glass Technology.—Royal Victoria Station Hotel, Great Central Railway, Sheffield. Fourth annual dinner. 7 p.m. for 7.15 p.m.

THURSDAY, APRIL 27TH.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. "Protective Appliances for Turbo-alternators," by Mr. J. A. Kuyser. 6 p.m.

FRIDAY, APRIL 28TH.

Institution of Electrical Engineers: Scottish Centre.—The Technical Institute, Dundee. Paper: "Single and Three-phase Alternating-current Commutator Motors with Series and Shunt Characteristics," by Professor S. Parker Smith. 7.30 p.m.

WEDNESDAY, MAY 3RD.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. General meeting. The twelfth annual May lecture on "The Relation of the Elements," by Professor Sir Ernest Rutherford, F.R.S. 8 p.m.

THURSDAY, MAY 4TH.

Iron and Steel Institute.—Connaught Rooms, Great Queen-street, London, W.C. Annual dinner. 7 for 7.30 p.m.

THURSDAY AND FRIDAY, MAY 4TH AND 5TH.

Iron and Steel Institute.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting. Annual dinner, Thursday, May 4th, at Connaught Rooms, Great Queen-street, W.C.

TUESDAY, MAY 30TH, TO FRIDAY, JUNE 2ND.

Institution of Electrical Engineers.—Summer Meeting in Scotland. Ladies invited. For programme, see page 326.